Adaptive Measurement-Based Traffic Engineering in Packet-Switched Radio Access Networks

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Adaptive Measurement-Based Traffic Engineering in Packet-Switched Radio Access Networks

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To my past and present friends in Atlanta — you all made this time here so worthwhile.

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AF	assured forwarding
ATM	asynchronous transfer mode
BE	best effort
CAC	connection admission control
CBR	constant bit rate
CR	core router
CR-LDP	constraint-based routing label distribution protocol
demux	demultiplexer
DiffServ	differentiated services
DP	discovery probe
DSCP	differentiated services codepoint
EBP	equalization of blocking probabilities
EF	expedited forwarding
EGW	edge gateway
ER	edge router
EWMA	exponetially weighthed moving average
FEC	forwarding equivalence class
FTN	FEC-to-NHLFE
HI	host identity
HIP	host identity payload
IETF	Internet Engineering Task Force
IGP	interior gateway protocol
ILM	incoming label map
IntServ	integrated services
IP	Internet protocol
IPv4	Internet protocol version 4
IPv6	Internet protocol version 6

ITU	International Telecommunication Union
LDP	label distribution protocol
LSFSB	local state fair share bandwidth
LSP	label switched path
LSR	label switching router
MAP	mobility anchor point
MATE	MPLS adaptive traffic engineering
MH	minimum hop
MIPv4	Mobile Internet protocol version 4
MIPv6	Mobile Internet protocol version 6
MPLS	multiprotocol label switching
NHLFE	next hop label forwarding entry
ns-2	network simulator version 2
OSI	open system interconnection
PHB	per-hop behavior
PP	probe packet/probe packet-based algorithm
PQS	path queue state/path queue state-based algorithm
PRI	priority
QoS	quality of service
QSRC	queue service ratio correction
RAN	radio access network
RAS	radio access server
RATES	routing and traffic engineering server
REA	HIP readdress packet
RFC	request for comments
RP	reservation probe
RSVP	resource reservation protocol
RTP	real-time transport protocol
SPF	shortest path first

TCL	tool command language
TCP	transmission control protocol
TE	traffic engineering
TPED MBAC	two-phase edge-to-edge measurement-based admission control
UDP	user datagram protocol
VBR	variable bit rate
VCI	virtual channel identifier
VoIP	voice over Internet protocol
VPI	virtual path identifier
WDP	widest disjoint paths
WRR	weighted round robin
WSP	widest shortest path

SUMMARY

In this research, we propose a framework for measurement-based traffic engineering and connection admission control in radio access networks based on the Internet Protocol (IP). This framework is evaluated by simulation using the popular network simulator ns-2. The framework is adaptive to changes in the network load and can distinguish between different types of service. All traffic engineering decisions are made by edge routers (ERs) at the rim of the network domain. Multiple disjoint paths are configured between those ERs. Network state information is gathered in two different fashions. We evaluate a scheme based on the states of the queues on each alternative path and a scheme based on end-to-end probe packet transmission characteristics on each alternative path. Both schemes are compared to a shortest path first (SPF) routing approach.

CHAPTER 1

INTRODUCTION

1.1 Motivation

As the Internet evolves and other networks migrate to Internet technologies, the need for a guaranteed quality of service (QoS) in such internetworks becomes more and more apparent. Radio access networks (RANs), which connect mobile phones or other mobile computing equipment to a network backbone, are such a type of network. RANs are fixed (wired) networks of a metropolitan area size.

Since mobile, wireless communications and the Internet are converging, network carriers are starting to deploy Internet protocol (IP) technologies in these originally telephony-oriented networks. However, the packet switching paradigm of IP poses problems since the services in telephony networks require firm constraints on e.g. bandwidth or delay. Furthermore, the mobility of a host with respect to its point of attachment to the network is also an issue that raises problems in IP-based networks. IP in its standard form cannot provide the required QoS guarantees, nor does it support mobile hosts. Several technologies have been developed to address these shortcomings. Some of these are briefly introduced in Chapter 2.

The proposed new framework in this thesis facilitates IP-based RANs to guarantee certain qualities of services for communication connections throughout them by incorporating several technologies designed to augment or extend the capabilities of IP. Moreover, the framework is designed to use the network resources more efficiently by mapping incoming connections on a path through the network that both has spare resources and the capability to maintain the connection's QoS requirements. The goal is to have a simple and distributed framework without any centralized servers that is able to give QoS guarantees for admitted traffic in a radio access network.

The framework proposed in this thesis distributes traffic over a number of different possible paths between the ingress and egress points of the RAN. The ingress points gather state information for each possible path with respect to all different service classes. This state information is used to render connection admission decisions. If a connection is admitted to the network, one path is picked to carry the connection's data packets until it terminates.

We investigate two approaches that differ in the way state information is gathered, one based on queue state information in the interior nodes of the network and one based on probe packet measurements over paths through the network. The main focus of this research is on the latter.

1.2 Dissertation Outline

Chapter 2 gives background information about technologies used in or related to this research, including traffic engineering, quality of service, connection admission control, and label switching. Additionally, related approaches are outlined briefly.

In Chapter 3, we introduce the proposed framework architecture and address the assumptions we made regarding topology, traffic, and general modeling issues. Furthermore, we describe the implementation of the simulator we used to obtain performance results.

Chapter 4 describes the proposed path queue state-based traffic engineering and connection admission control algorithm. We explain the overall algorithm operation. Moreover, we discuss the metrics used by the algorithm and evaluate the accuracy of the measurements used to acquire these metrics.

In Chapter 5, we present the probe packet-based traffic engineering and connection admission control algorithm. The algorithm operation is explained, and the metrics used are outlined. Furthermore, we investigate the accuracy and intrusiveness of the measurements. Two probing schemes for bandwidth estimation and reservation are developed and evaluated in the course of this chapter.

In Chapter 6, we show performance results of our algorithms. This includes the performance of the connection admission control and the achieved quality of service of admitted connections.

In Chapter 7, we draw conclusions based on the performance results. Additionally, we outline the contributions of this research and point out directions for further research.

CHAPTER 2

BACKGROUND

2.1 Components Needed

To achieve the stated goals, the RAN has to serve or support several functions. First of all, since we want the RAN to be IP-based, there has to be a means to support mobility, i.e. nodes must be able to change their connectivity and still be able to send or receive data packets. Second, the network has to support distinct types of service. Such types include e.g. voice and data connections. Third, connection admission control is needed to assure whether enough resources are available to support a call (or a connection in the general sense—we will use both terms interchangeably throughout this work) without interfering with the communications of other users. Fourth, the proposed traffic engineering module requires routing traffic over explicit routes. This cannot be accomplished by means of standard IP and therefore needs to be explicitly supported by the network. Fifth, network state information has to be gathered to facilitate some of these functions.

Some of this functionality can be accomplished or partially implemented with the help of proposed standards of the Internet Engineering Task Force (IETF).

2.1.1 Mobility

In IP, nodes are addressed by their IP address. This address can be split up in two parts: the network portion and the host portion. The network portion determines the subnet a node is connected to and affects how a packet is routed to this node. In general, if a node connects to a different network, it needs to change its IP address so that packets can be routed to it. However, if the IP address of a node changes, it cannot be reached under its original address. Ongoing connections are therefore interrupted, and new connections can only be set up if the new IP address is known by the caller. Mobile IP addresses these problems. It is already standardized for IP version 4 (IPv4) [33] while it is still under development for IP version 6 (IPv6) [22].

2.1.1.1 Mobile IP Version 4

In a nutshell, a Mobile IP version 4 (MIPv4) node has a permanent home address. If the mobile node is on its home link, everything works as usual. If the mobile node connects to a foreign link, it acquires a care-of address from a foreign agent. Then it registers this care-of address with its home agent. Other nodes, referred to as corresponding nodes in the terminology of Mobile IP, that want to communicate with the mobile node send packets to its home address. The home agent intercepts these packets and tunnels them to the care-of address of the mobile node. If the mobile node replies, it sends packets directly to the corresponding node without tunneling but with its home address in the source address field of the IP header.

2.1.1.2 Mobile IP Version 6

Mobile IP version 6 (MIPv6) has several optimizations. Tunneling is optional since packets can be source routed with the help of IPv6 routing headers. Additionally, link local addresses and stateless address autoconfiguration [38] render foreign agents unnecessary. Packets bound to the mobile node no longer have to be sent through its home agent. Corresponding nodes can send them directly to the care-of address of the mobile node. The mobile node informs corresponding nodes if its care-of address changes with a destination options header.

2.1.1.3 Hierarchical Mobile IP Version 6

A refinement of MIPv6 is Hierarchical MIPv6 [37]. It is designed to reduce the time spent on handoffs. This is achieved by introducing mobility anchor points (MAPs). MAPs act as local home agents and are hierarchically arranged in the network topology.

2.1.1.4 Host Identity Payload Protocol

The host identity payload (HIP) protocol [30] takes a different approach. The HIP protocol operates at Layer 3.5 in the open system interconnection (OSI) reference model between the network and the transport layer. In IP, an address serves both as a means to identify a host (or more precisely, an interface of this host) and to determine the point of attachment to the network. HIP separates those functions. In HIP, the host identity (HI) resides at layer 3.5. Such a HI can be resolved to an IP address. The advantage is that the transport layer uses the HI for its internal state rather than the IP address. Since the transport layer is oblivious to the IP address, the address can change without interrupting communications. Peers can notify each other about changes of their IP address by readdressing packets (REAs). Additionally, rendezvous servers are used to forward REAs in case both nodes do not know about each other's IP address.

2.1.2 Quality of Service

Different types of connections require different qualities of service (QoS), e.g. interactive voice connections have tight constraints on delay while bulk file transfers may require a large throughput. There are two approaches to guarantee a certain QoS under such constraints.

First, strict QoS guarantees are accomplished by the integrated services (IntServ) architecture [10] in conjunction with the resource reservation protocol (RSVP) [11] used for signaling. This framework allows reserving resources on a path through the network, but it has shortcomings with regard to scalability. The problem is that every router on that path has to maintain per-flow state information.

Second, the differentiated services (DiffServ) architecture [7], which gives a loose notion of QoS, enables the network to optimize the transport of data packets according to certain requirements. DiffServ only uses different per-hop behaviors (PHBs) for different classes of traffic rather than giving guarantees on these transport characteristics. Such PHBs are implemented on every DiffServ-enabled router by mapping different traffic aggregates to different queues. These traffic aggregates are distinguished by the DiffServ codepoint (DSCP) in the IP header. Several PHBs have already been defined:

- Expedited forwarding (EF), a high priority service trying to achieve zero packet loss, minimal queuing delay, and minimal jitter [14, 13],

- Assured forwarding (AF), a group of several PHBs giving a variety of different forwarding assurances by defining four classes (distinguished by the resources available per class, namely buffer space and bandwidth) with three different drop precedences

[19],

- Best effort (BE), a low priority service equivalent to the service in DiffServ-unaware networks (like today's Internet).

DiffServ alone does not guarantee any quality of service in an end-to-end fashion. All it does is providing differentiated service to packets on a hop-by-hop basis. To address this, DiffServ can be used in conjunction with connection admission control (CAC) to ensure that the network can support additional data without degrading the QoS of the data already admitted. Moreover, out-of-profile flows or flow aggregates can be addressed by means of traffic shapers or policers.

2.1.3 Label Switching

Traffic engineering (TE) is an important means to utilize resources in networks more efficiently, to improve service, and to introduce resilience to a network. The TE scheme proposed in this work works at the granularity of single flows and maps them adaptively to one path out of a set of multiple alternative paths. This enables the network to cope with high point loads by distributing this load. To be able to use different forwarding behaviors on a per-flow basis in IP-based networks, multiprotocol label switching (MPLS) [35] can be utilized. MPLS forwards all packets belonging to a certain forwarding equivalence class (FEC) over the same path through the network while this FEC can—but does not have to—be based on the destination address.

Note that a technology like MPLS ensures that packets of the same flow take the same route. Otherwise, the result would be a very high jitter, which is unsuitable for e.g. voice over IP connections, and packet reordering, which leads to a poor performance of the transmission control protocol (TCP) used for e.g. Web or mail applications.

In contrast to standard IP routing, which analyzes the network prefix (or aggregated network prefixes) of an IP address on every hop to render a routing decision, MPLS is based on label swapping similar to the mechanism used in asynchronous transfer mode (ATM) networks. And in fact, if MPLS is used over ATM, the label is encoded in the ATM virtual channel identifier (VCI) and virtual path identifier (VPI). In packet-based networks the label resides between the layer 2 and the layer 3 header. Therefore, MPLS is also referred to as a shim layer or as a layer 2.5 technology. An additional feature of MPLS is hierarchical labels, i.e. a packet can have multiple labels. In other words, a label switched path (LSP) through the network can contain another LSP as a part of it. Such a chain of labels is referred to as a label stack.

In MPLS, a label switching router (LSR) determines the next hop of a packet using three tables. The next hop label forwarding entry (NHLFE) table contains information about what to do when a packet is forwarded. This is one of these actions: exchange the top label, pop the label stack, or exchange the label and push a new label on the label stack. If an unlabeled packet arrives at an ingress router (the first router of an LSP), it is labeled by looking up a mapping in the FEC-to-NHLFE map (FTN). If it is labeled, the incoming label map (ILM) is used to map the incoming label to an NHLFE. Note that MPLS also allows one-to-many mappings in both FTN and ILM. However, when the packet is forwarded, exactly one of these mappings has to be chosen by the LSR.

Labels have only a local scope and are agreed upon by two neighboring routers. To set up LSPs and exchange label information, MPLS assumes the availability of an additional protocol. One such protocol is the constraint-based routing label distribution protocol (CR-LDP) [21]. CR-LDP fits our needs for traffic engineering because it allows creating LSPs over explicit routes.

2.2 Related Work

2.2.1 Resource Reservation

The scalability shortcomings of the IntServ approach led to reservation schemes that do not have to track each individual flow of traffic. In Request for Comments (RFC) 2998 [5], Bernet *et al.* suggest a framework for running IntServ over DiffServ domains. IntServ is used for end-to-end QoS while DiffServ is used in between, e.g. in the network backbone. The framework is based on policing the traffic at the rim of the DiffServ domain. Additionally, IntServ nodes can condition the traffic so that it actually fits to the traffic pattern reserved. One means stated in [5] to assure the provisioning of resources in the DiffServ domain is the use of a bandwidth broker. Such bandwidth brokers, or other centralized entities managing resources, are common to regulate the apportionment of resources [32, 3].

Another approach is taken by the scalable resource reservation protocol framework introduced by Almesberger *et al.* [2]. A user injects packets in the network with a request bit set. The network forwards these packets at a rate it is going to accept. The receiver reports the rate these packets are received with to the sender. Now the sender sets a reserved bit rather than the request bit set previously. The network in turn tries to forward these packets at the same rate as the packets with the request bit set. Scalability is achieved since there is no per-flow information needed in the network. Every router renders its own decisions without distinguishing individual flows yielding a distributed reservation scheme relying on statistical properties of flows.

2.2.2 Connection Admission Control

Connection admission control based on end-to-end measurements of packet transmission characteristics is addressed in a number of papers. The frameworks presented in [16], [6], and [8] use network probe packets for admission control. Before a host sends regular data packets, it sends probes and measures the characteristics of this probe transmission. If these characteristics suffice some requirements, it is assumed that the network can support the additional traffic, and the host starts to send regular data packets. The latter receive a better service from the network than probes do by mapping them to a different queue on each node dedicated only for actual data packets.

This idea is further refined in the two-phase edge-to-edge distributed measurement-based admission control (TPED MBAC) [34] suggested be Rhee *et al.* Probing is done in two steps. In the quantitative provisioning phase, it is determined if bandwidth requirements are met. In the qualitative provision phase it is evaluated if the QoS requirements are fulfilled.

However, this mainly addresses traffic that has a constant bit rate (CBR). In reality, the traffic characteristics of many applications have a variable bit rate (VBR). Borgonovo *et al.* present such VBR issues for their probing framework initially described in [8] in [9]. They find that it is not sufficient to use the average rate of a VBR source to simplify it to a CBR source because if multiple VBR sources peak, the network becomes overloaded. Instead, information on VBR characteristics has to be gathered by using a sufficiently long probing phase.

Li *et al.* introduced the fair intelligent admission control (FIAC) scheme in [29]. In FIAC, end nodes send resource discovery packets through the DiffServ domain, in which the core routers in that domain fill in information on their QoS state.

2.2.3 Measuring Network Properties

While measuring the packet loss rate, delay, and jitter by means of probing can be implemented in a straightforward fashion, measuring the *available* bandwidth, i.e. the bandwidth that is not used on path, is more complicated. Note that this is not the bottleneck bandwidth, which can be measured more easily [23]. Most approaches to measure available bandwidth are based on packet dispersion. Carter and Crovella initially used this idea in their measurement tool cprobe [12]. Cprobe sends a train of packets to a node at the endpoint of the path of interest. This train is bounced at the endpoint of that path. The available bandwidth is assumed to be the number of bytes in that train divided by the time it takes to receive the complete bounced train of packets. The initial rate this train is sent with is determined by measuring the bottleneck bandwidth beforehand. For this purpose, Carter and Crovella developed the bprobe program, which is able to determine this metric. In recent research, however, it turned out that these measurement techniques are questionable [15]. Additionally, these probing techniques strongly interfere with other traffic on the network.

2.2.4 Traffic Engineering Frameworks

In [17], Elwalid *et al.* present a framework for MPLS adaptive traffic engineering (MATE). MATE is designed to balance fluctuations of the network load by sending traffic flows to the same destination over different routes. These routes are implemented as LSPs. MATE gathers state information of these LSPs by using probe packets that are sent periodically from the ingress to the egress router of an LSP. These statistics and a path cost function are used to decide to which LSP a traffic flow is shifted.

In [3], Aukia *et al.* present a framework based on a routing and traffic engineering server (RATES) of their design. This centralized server keeps track of reservations (see also Section 2.2.1). Based on this knowledge, LSPs are chosen.

Another approach to dynamically distribute a given traffic load over a given network is to recompute routes periodically using an interior gateway protocol (IGP). Hollick *et al.* give a good overview on this topic in [20] for QoS-aware IGPs in RANs.

Barlow presents the local state fair share bandwidth (LSFSB) algorithm, a traffic engineering algorithm for radio access networks, in [4]. LSFSB assumes DiffServ, MPLS, and Hierarchical MIPv6 support throughout the network. The design aims to be simple and fast, and it uses the available resources sparingly. The algorithm relies — as the name implies — on local state information only. Local in the scope of LSFSB refers to state information available on a single node. LSFSB does not require distribution of network state information. Hence, the only signaling required is due to LSP setup using CR-LDP. The radio access servers (RASs) on the edge of the network choose the LSP on which admitted traffic is forwarded. This happens in two stages. Stage one assures a fair share of resources among all RASs on the edge of the network that inject traffic. The decision which path is chosen is based on a widest-shortest path algorithm. Stage two is used to overload the network. This is possible since best effort connections can yield parts of their bandwidth to other connections. A more detailed analysis of the operation and performance of LSFSB can be found in Appendix A.

Nelakuditi and Zhang propose and evaluate a framework both to select a number of possible paths between a source and a destination node (a set of candidate paths) and to pick paths out of this set for new flows in [31]. A widest disjoint path (WDP) algorithm is used to calculate the set of candidate paths with the maximum width. The width of a set reflects the total amount of bandwidth that can be transmitted over this set of paths. If a path does not increase the width because it e.g. shares a bottleneck with another path in the set, it is pruned. The latter calculations are based on global state information that is distributed in sparse intervals. Then, a path for a new incoming flow is picked such that all paths in the set have equal blocking probabilities (equalization of blocking probabilities, EBP). This decision is based on information locally available at the node.

This scheme is compared to best path routing based on a widest shortest path (WSP) algorithm. Best path routing requires global knowledge of the network state. Since the update interval has to be reasonably long to keep the signaling load on the network small, best path routing often operates on stale information. This leads to synchronization problems where multiple nodes simultaneously congest similar paths because their stale information indicates spare capacity.

The results in [31] show that the WDP/EBP scheme outperforms best path routing while minimizing the signaling overhead.

CHAPTER 3

FRAMEWORK ARCHITECTURE AND ASSUMPTIONS

3.1 Topology

The network we assume for this work is a simple radio access network (RAN) setup as in [4]. Figure 1 shows this topology. Mobile devices connect to the radio access servers (RASs) on the rim of the network. Those connect to edge routers (ERs) on the edge of the core network. There is one special ER called the edge gateway (EGW) in the core network that interfaces other RANs and the Internet. To keep this nomenclature general, we also consider the possibility of other routers in the core network that do not inject traffic. These routers are referred to as core routers (CRs). In the scope of this research, all ERs and CRs make up one traffic engineering and CAC domain. The ERs make CAC decisions and pick a path for incoming traffic on a per-connection basis.

Between each pair of ERs, three disjoint label switched paths (LSPs) are established. This results in a total of 60 LSPs in the network, which are set up prior to network operation.

3.2 Traffic Load and Service Classes

We consider four different services with distinct traffic flow characteristics. The characteristics used were chosen to demonstrate proof of concept. The first one uses the EF PHB and the User Datagram Protocol (UDP) for data transport. 200 byte-sized packets are sent with a constant bit rate of 80 kbps in both directions. This models voice connections as voice over IP (VoIP) sessions. The assumed compression technique is specified in the International Telecommunication Union (ITU) standard G.711. The output of this compressor is a CBR stream of data at 64 kbps. This stream is transmitted over the network using the real-time transport protocol (RTP) [36], which operates on top of UDP and IP. This overhead increases the data rate to 80 kbps at the IP layer. Every packet carries a payload of 160 bytes corresponding to 20 ms of speech. The second class uses the AF

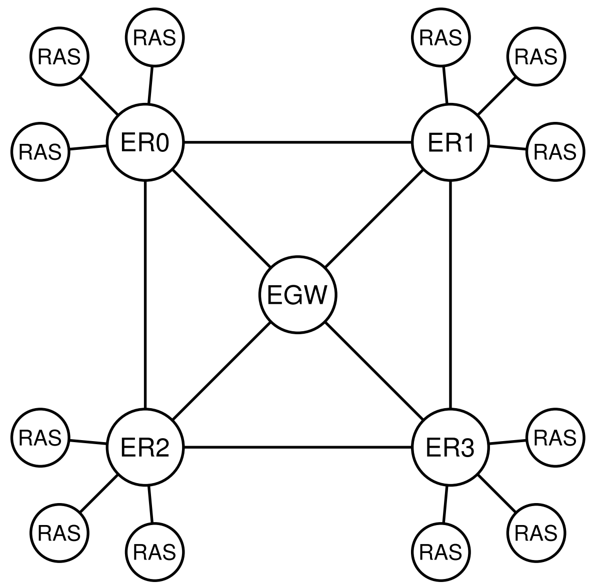

Figure 1: Simple radio access network topology

PHB and UDP. Packets are sized 500 bytes, and the bit rate is 100 kbps in both directions. The third class uses the AF PHB and the Transmission Control Protocol (TCP) for data transport. The packet size is 500 bytes. The fourth class uses the BE PHB with TCP and a packet size of 1000 bytes. Both TCP traffic classes send with variable bit rates, which is inherent to TCP. However, at the ingress ER, the TCP flows are policed to 100 kbps using a token bucket. Moreover, both TCP traffic classes are unidirectional. The data on the reverse path consists only of 40 byte-sized acknowledgment packets. To uniquely identify each class, we label them by their PHB and their transport protocol: *ef-udp*, *af-udp*, *af-tcp*, and *be-tcp*. The probability that a new connection is an *ef-udp* connection is $\frac{1}{3}$. For *af-udp*, the probability is $\frac{1}{6}$; for *af-tcp*, it is $\frac{1}{6}$; and for *be-tcp*, it is $\frac{1}{3}$. Table 1 gives an overview of these parameters. When a connection fails to achieve its minimum QoS requirements, it is terminated. For *ef-udp*, no more than one loss per 2 second interval is tolerated. Both *af-udp* and *af-tcp* have to maintain a loss rate of no more than 2 packets during the last 2 seconds. Currently, there is no minimum QoS requirement for *be-tcp*.

Connections arrive exponentially distributed at the rim of the network with an inter-arrival time of λ. The channel holding time follows a lognormal distribution with parameters

Table 1: Traffic classes

	PHB	Transport	Packet size	Rate	Direction	Probability
ef-udp	EF	UDP	200 bytes	80 kbps	bidirectional	$\frac{1}{3}$
af-udp	AF	UDP	500 bytes	100 kbps	bidirectional	$\frac{1}{6}$
af-tcp	AF	TCP	500 bytes	$\leq$ 100 kbps	unidirectional	$\frac{1}{6}$
be-tcp	BE	TCP	1000 bytes	$\leq$ 100 kbps	unidirectional	$\frac{1}{3}$

$\mu_{\mathrm{cht}} = 3.37$ sec and $\sigma_{\mathrm{cht}} = 1.25$ sec (similar to [4]). Two parameters determine the distribution of connections in the network: p_{EGW} is the probability that the EGW is part of a connection, and p_{ER0} is the probability that ER 0 is part of a connection. Figure 1 shows these nodes.

The network deals with these different services by means of three different physical queues on each node, which are served in a weighted round robin (WRR) fashion. The weights are configured to 7 for EF, 4 for AF, and 1 for BE, respectively.

3.3 Framework Architecture

The framework consists of a core network with DiffServ support, which is bordered by ERs. These ERs gather network state information. Based on this state information, an ER decides whether to admit an incoming connection request and on which path to forward it. The achieved QoS of this connection is monitored, and the connection is terminated if its QoS goals are not achieved. For scalability reasons, this monitoring can happen further down the network hierarchy (even on the mobile node itself), and an insufficient QoS can be signaled to the ER. Figure 2 depicts this architecture.

3.4 Mobility

Since the framework works at a per-flow granularity, mobility issues do not affect the performance of the traffic engineering and connection admission control modules. All ERs always have recent state information available so that connections can be re-admitted in a fast manner. The signaling for roaming nodes and the changes in delay and jitter due to hand-offs are beyond the scope of this research.

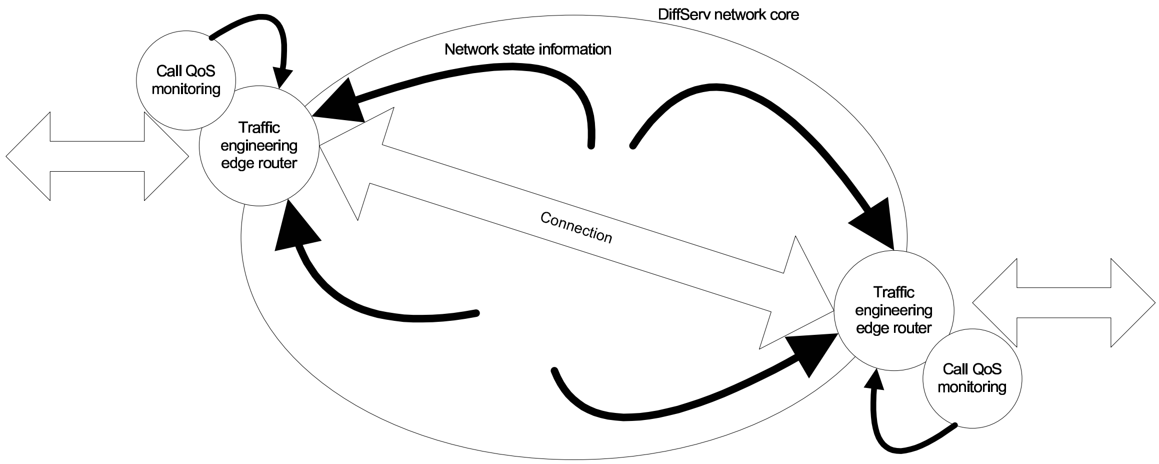

Figure 2: Framework architecture overview

3.5 Simulator Architecture

3.5.1 Implementation

The simulator is implemented using the network simulator version 2 (ns-2) available at [1], a simulation package based on both fast C++ code and flexible scripts written in the tool command language (TCL). All processing at a packet-level is implemented in C++. This includes the core network, network state gathering in the core network, and call quality of service (QoS) monitoring. Processing at the call level is implemented in TCL. This includes evaluating state information to render an admission decision or choosing the right path through the core. Additionally, all setup, initialization, and configuration is conducted in TCL scripts.

3.5.2 Edge Router Functionality

Although all information flows towards the edge routers, the simulator implementation for network state data works in a way that edge routers query it. For the global queue state algorithm, information is queried directly from each queue while the probe-based scheme uses a number of probe agents on the rim of the network, which can be queried. The connection QoS monitoring works different. A connection is monitored, and when it fails to meet certain criteria, a callback function in the traffic engineering edge router module is triggered that terminates the call, resets all associated state, and puts all resources back into a connection pool.

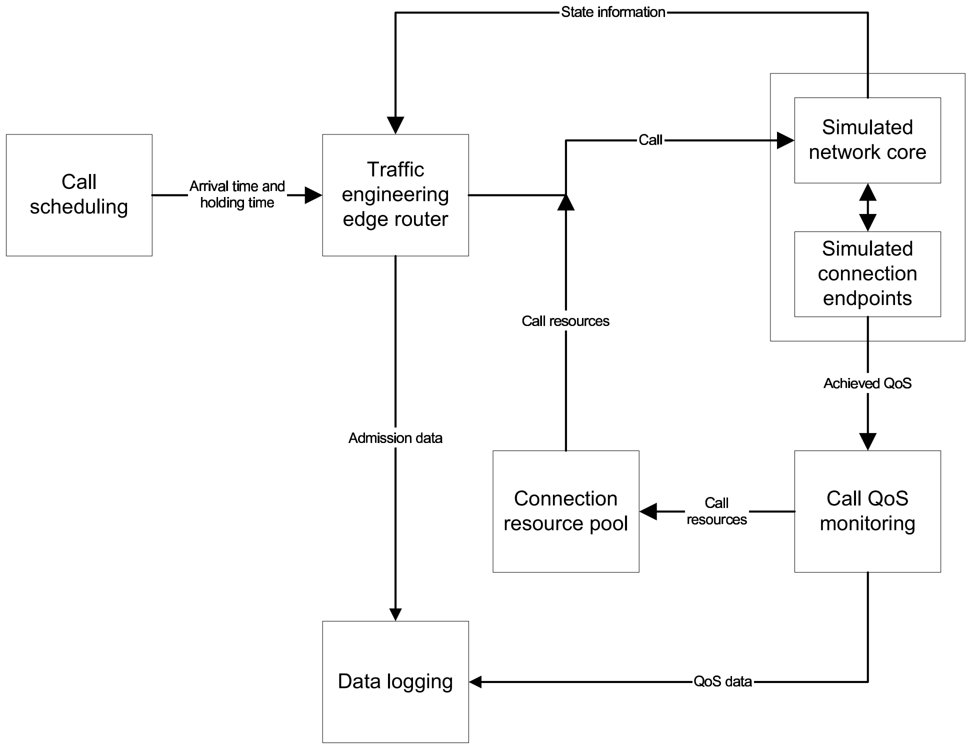

Figure 3: Block diagram of the simulator

3.5.3 Overview of Modules

In Figure 3, the dependences and relationships among the different modules are sketched. First, connections are scheduled. Scheduled connections invoke a function in the traffic engineering edge router module as soon as the simulation has advanced to their start time. The traffic engineering edge router module then renders an admission and routing decision based on state information from the network core. In case the connection is admitted, resources to simulate the connections are taken from a pool, and the connection is started. After the connection terminates, the resources are put back into the pool. This scheme is a speed-up since connection resources have not to be created and configured for every single connection. Both call QoS data (per-packet statistics) and admission data (per-connection statistics) are logged.

3.5.4 Simulation

Each simulator run starts with a five second initialization period that is used to set up LSPs using the label distribution protocol (LDP). After this period, connection requests are scheduled. A 55 second warm-up period follows to ensure that the network is in steady state. Then, a 150 second simulation period is used to gather the actual data.

CHAPTER 4

THE PATH QUEUE STATE-BASED ALGORITHM

4.1 Overview

In this chapter, we outline a traffic engineering and connection admission control scheme based on path queue state measurements. We describe the metrics the algorithm works on, evaluate their accuracy, and explain the operation of the proposed scheme.

The proposed algorithm renders its decision based on path queue state (PQS) information gathered by edge routers (ERs). Each ER gathers information on the states of the queues on all paths to each peer ER it has. Then, the expected QoS properties for each path are computed. ERs render admission decisions based on this information and pick a suitable path for newly admitted traffic flows. A brief introduction including results of an earlier version can also be found in [28].

4.2 Metrics

Three different metrics are considered: the average queue length of each of the three physical queues (as seen by the random early detection algorithm [18] of each queue), the drop rate for each of the three physical queues, and the link utilization (based on the idle time of the queue server). The two latter values are measured over a 100 ms interval. The resulting value is then filtered using an exponentially weighted moving average (EWMA).

The edge routers can read these values without any delay, i.e. there is no signaling packet involved. This is a vast simplification for the implementation for the simulation software. Moreover, we do not expect this property to have a big impact on the results since our algorithm incorporates EWMA values rather than relying on exact instantaneous measurements. A further discussion of this follows in Section 4.5.

Based on the highest link utilization on a path, an estimated available bottleneck bandwidth A for that path is calculated. Furthermore, all average queue lengths along a path are added up. Since the average packet size for each queue is known (Section 3.2), the average service rate can be estimated. Based on the aggregated queue length and the service rate, a delay estimate δ is calculated. The sum of all loss rates is denoted l.

4.3 Accuracy of Measurements

4.3.1 Delay

To evaluate the performance of the delay measurement, Poisson traffic is sent over two links in the network. Three reference flows of 700 kbps (EF), 400 kbps (AF), and 100 kpbs (BE) are used to measure the actual delay per packet while a cross traffic flow is ramped up in steps of 700/400/100 kpbs (for EF/AF/BE) every 10 seconds.[1]The rates are chosen to match the queue weights for the WRR scheduling (Section 3.2). Figure 4 shows the service ratios at the bottleneck queue. The service ratios stay constant as more traffic is injected.

Let a path p consist of n links l_i with $i = 1 \ldots n$. Each link has three physical queues $q_{i,PHB}$ with $PHB \in \{\text{EF, AF, BE}\}$. A queue for the PHB PHB has a weight of w_{PHB}. The average length of $q_{i,PHB}$ is denoted as $m_{i,PHB}$. The propagation delay for each link is δ_{prop}. The delay estimate δ_{PHB} is then calculated as

$$\delta_{PHB} = n\delta_{\text{prop}} + \frac{\sum_{p \in \{\text{EF, AF, BE}\}} w_p}{w_{PHB}} \cdot \sum_{i=1}^{n} m_{i,PHB}. \tag{1}$$

Figure 5 shows the results for EF traffic. The delay starts to increase in small steps every 10 seconds. After 70 seconds, the network starts to be overloaded. The PQS estimate is slightly lower then the actual delay. The AF and BE graphs shown in Figure 6 and in Figure 7, respectively, are similar.

For the next evaluation, the queue weights do not match the traffic load anymore. The BE flow is increased by a factor of 10. Figure 8 shows how the service ratios vary over time. The result is an inaccurate delay estimate. Figure 9 shows the impact on the BE delay estimate.

[1]Note that EF, AF, and BE in the scope of this accuracy evaluation does not actually reflect the properties of these traffic classes as outlined in Section 2.1.2 due to the lack of a CAC scheme. It merely refers to the queue provisioned for this traffic class by the DiffServ framework.

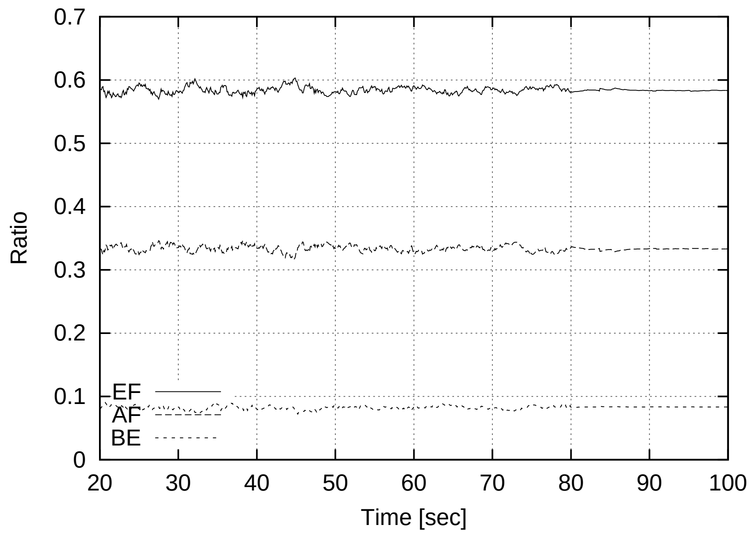

Figure 4: Ratios of service time granted to physical queues per PHB

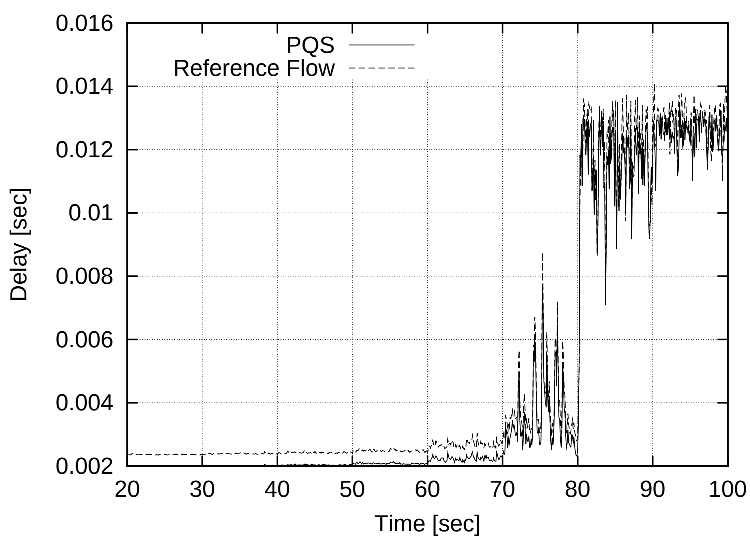

Figure 5: Delay estimate and delay of reference flow for the EF PHB

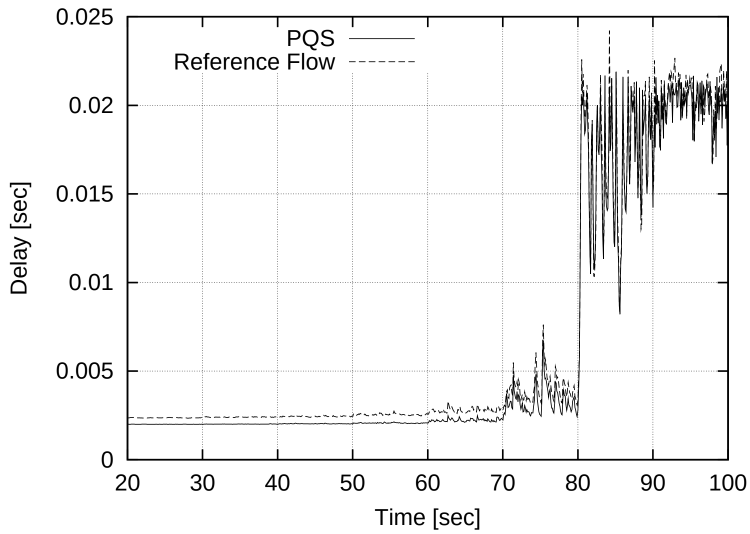

Figure 6: Delay estimate and delay of reference flow for the AF PHB

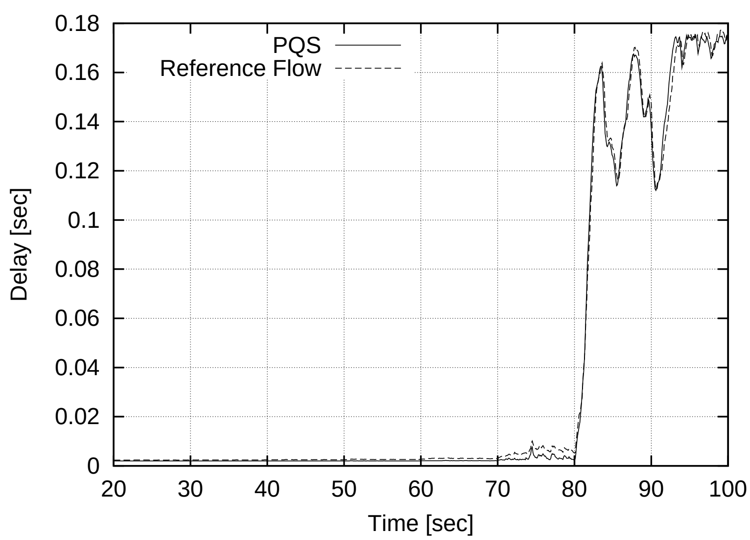

Figure 7: Delay estimate and delay of reference flow for the BE PHB

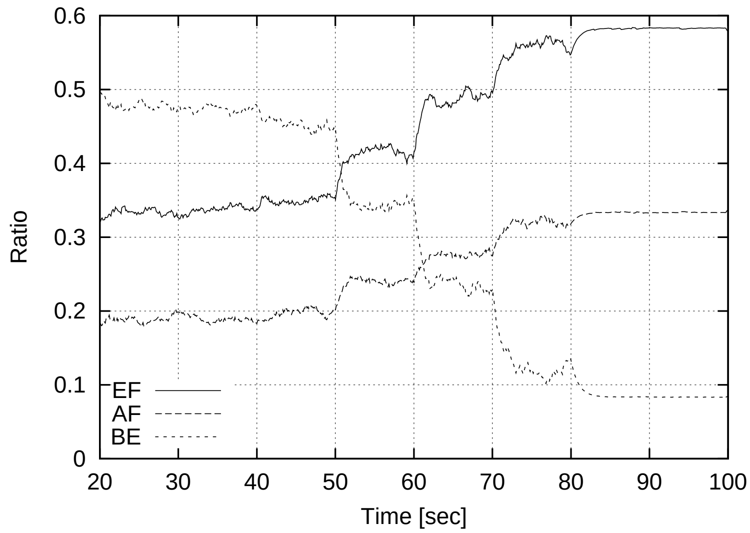

Figure 8: Ratios of service time granted to physical queues per PHB for an alternative traffic load

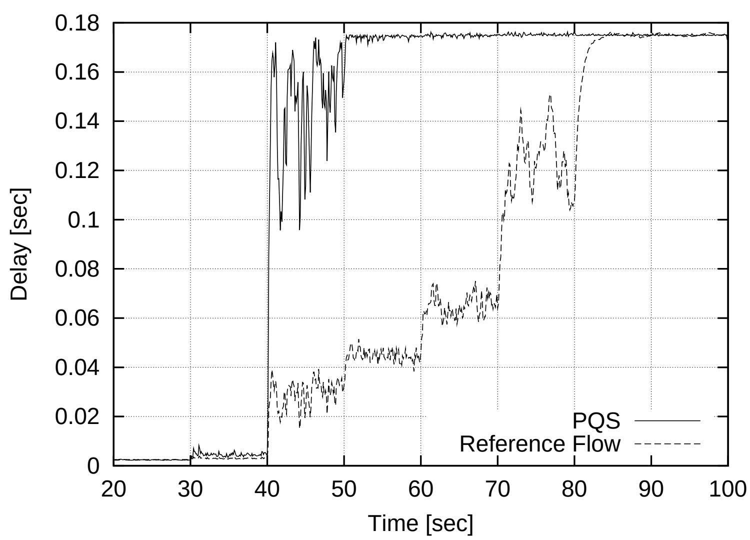

Figure 9: Delay estimate and delay of reference flow for the BE PHB for an alternative traffic load

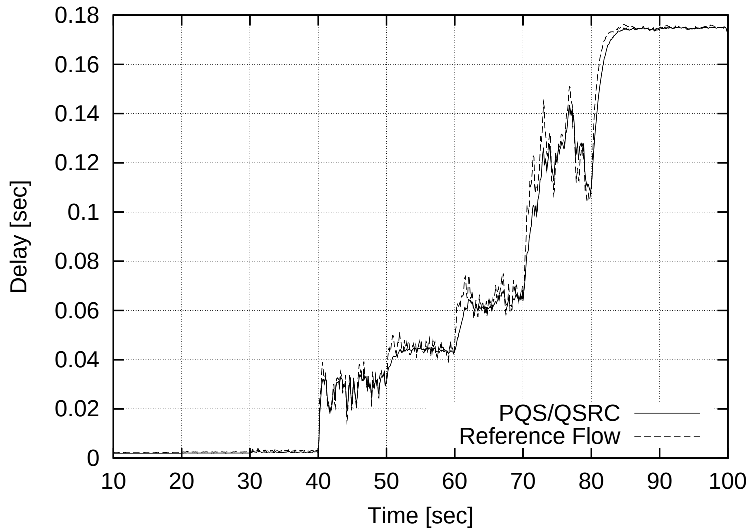

Figure 10: Delay estimate with QSRC and delay of reference flow for the BE PHB for an alternative traffic load

However, a more exact estimate can be calculated when each queue is queried about the service ratio $s_{i,PHB}$ for PHB PHB observed during a past interval, and (1) is altered to

$$\delta_{PHB} = n\delta_{\text{prop}} + \sum_{i=1}^{n} s_{i,PHB} \cdot m_{i,PHB}.$$

Figure 10 shows the delay estimate using this queue service rate correction (QSRC). The estimate is close to the actual delay experienced by the reference flow.

4.3.2 Bandwidth

Figure 11 shows the estimated available bandwidth based on the link utilization and the actual available bandwidth based on the information on sending traffic sources. Note that the latter neither accounts for dropped packets nor for fluctuation due to randomness. The estimate is slightly lower, and the measurement error becomes bigger as fewer bandwidth is available.

4.3.3 Loss

The loss metric implemented as described in Section 4.2 penalizes paths comprising links with losses rather than giving an estimate of the expected loss probability. Therefore, we do not show any further evaluations of this metric.

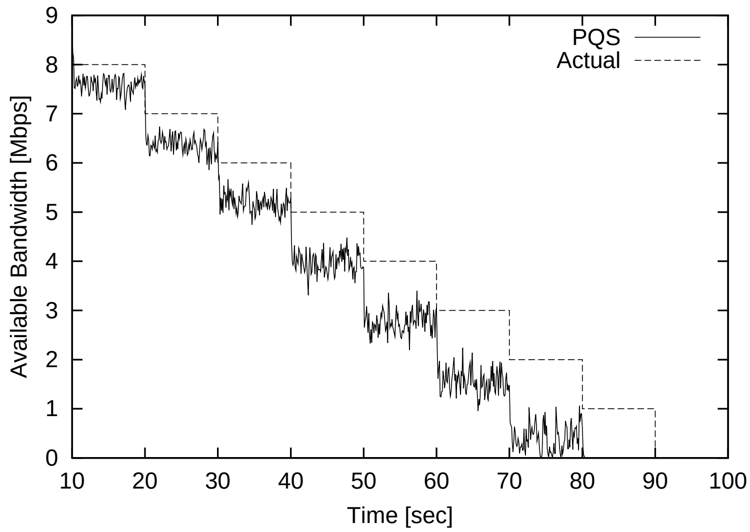

Figure 11: Available bandwidth estimate and actual available bandwidth

4.4 Connection Admission and Path Selection

The algorithm works in two steps. The first step is to check if new incoming traffic flows can be admitted to one of the three possible LSPs, and LSPs not capable of carrying more traffic are pruned from the set of feasible paths. Then a path is selected from the set of remaining paths.

4.4.1 Evaluating the Metrics

The decision for both steps is based on the three metrics described previously. A path is not pruned from the set of feasible paths if the bandwidth requirement B of the connection to be admitted satisfies the condition $B \leq \beta \cdot A$ where β is a parameter depending on the traffic class and A is the estimated bottleneck bandwidth. Moreover, the delay estimate δ has to be lower than a parameter $\delta_{\max}$, which depends again on the traffic class. The last requirement for a path to stay in the set of feasible path is that the sum of all drop rates l is lower than a traffic class-dependent parameter $l_{\max}$. The values for β, $\delta_{\max}$, and $l_{\max}$ we chose are presented in Table 2.

Table 2: Admission control parameters for the PQS algorithm

	β	$\delta_{\max}$	$l_{\max}$
ef-udp	3.0	29 msec	$5 \cdot 10^{-8}$
af-udp	3.0	233 msec	$1 \cdot 10^{-7}$
af-tcp	3.0	233 msec	$1 \cdot 10^{-7}$
be-tcp	0.5	∞	∞

4.4.2 Queue Penalties

To avoid that multiple ERs admit connections concurrently to paths that share a common link, each queue on a path a connection is admitted to receives a penalty. For EF connections the delay estimate for each queue is increased by 1 msec for an interval of 1 sec. Moreover, for EF and AF the available bandwidth EWMA is decreased by $1.5 \cdot B$. For BE, the available bandwidth EWMA value is decreased by $0.5 \cdot B$.

4.4.3 Decision

The selection of a path from the set of feasible paths is implemented in a rather straightforward manner. For EF and BE connection, the path with lowest estimated delay is selected. AF connections are routed over the path with the lowest estimated loss. Both the estimated delay and the estimated loss include the penalties of all queues on the considered path.

4.5 Implementation Issues

The actual implementation of the queue state querying and the setting of a queue penalty in real networks could be done by using setup packets that are sent between the two participating ERs before the actual data is flowing. However, additional delays are involved until all penalties are set. In a highly utilized network core, it is very likely that other ERs try to set penalties at the same time. Therefore, an actual implementation has to include some sort of handshake or mutual exclusion procedure.

Note that these mechanisms do not require per-flow state information. However, for distributing flows over different paths, ERs have to be aware of different flows to assign the appropriate MPLS labels to them.

CHAPTER 5

THE PROBE PACKET-BASED ALGORITHM

5.1 Overview

In this chapter, we propose a probe packet-based traffic engineering and connection admission control scheme. The metrics the algorithm works on are pointed out, and their accuracy is evaluated. Moreover, we describe two different approaches to address the measurement of available bandwidth and its reservation, one based on congesting links with low-priority packets and one based on two different types of low-priority packets. The algorithm used for the framework is based on the latter bandwidth reservation scheme. It is also described in [25].

The probe packet-based algorithm gathers network state information based on packet transmission characteristics between edge routers (ERs). Between each pair of ERs, probe packets are sent on every path between those ERs and for every class of service. The characteristics of the transmission are measured at the ER at the end of the path, the egress ER. It sends the results back in feedback packets to the ingress ER at the beginning of the path. In contrast to the path queue state-based algorithm introduced in Chapter 4, it is oblivious to the topology in the network core.

5.2 Probing Delay, Jitter, and Loss

Delay, jitter, and loss measurements are conducted by means of probe packets. These probes are small packets that are sent from an ingress ER to an egress ER through the core networks on all LSPs connecting these two routers. On every LSP, probe packets with different codepoints are sent periodically to measure the path properties for all available traffic classes. We assume support for expedited forwarding, assured forwarding, and best effort traffic (see Section 2.1.2). The properties of the transmission of these probes are measured at the egress router. Metrics can include e.g. the packet loss rate, delay, and

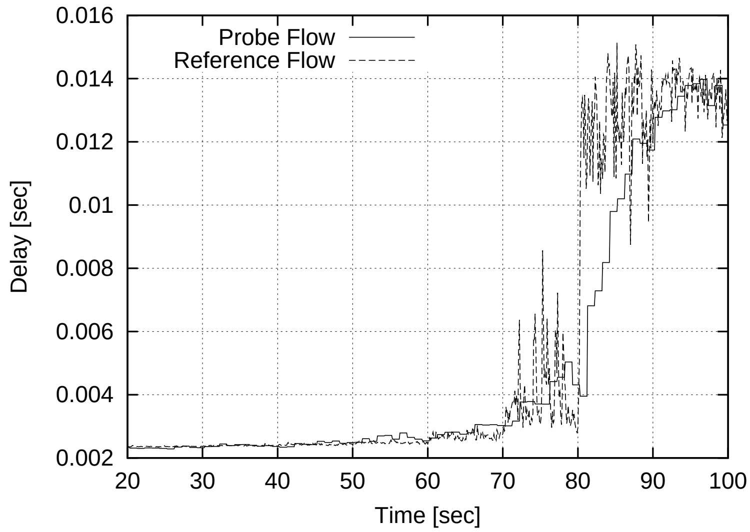

Figure 12: Delay of probe flow and of reference flow for the EF PHB

jitter. The egress router sends feedback packets periodically back to the ingress router. These feedback packets contain the measured characteristics of the probe stream received.

We developed extensions to the network simulator version 2 (ns-2) to facilitate the simulation of probe packets and feedback packets. Additionally, we added several meters to the simulator to efficiently gather per-flow data. Minor changes were applied to the DiffServ and MPLS modules in ns-2.

5.2.1 Accuracy of Measurements

To evaluate the accuracy of measurements, we impose the same traffic load as in Section 4.3 onto the network. The probe flow consists of probe packets sent out every 250 msec by the ingress ER. Every 1000 msec, a feedback packet containing the probing results is sent back from the egress ER at the end of the path to the ingress ER. The results in these packets are the considered metric—as seen at the ingress ER. Note that the reference flow values are measured directly on a per-packet basis at the egress ER.

5.2.1.1 Delay

Figure 12, Figure 13, and Figure 14 show the results of the measured probe delay and of the delay of a reference flow for EF, AF, and BE traffic. For a reasonably loaded network, both values show a good match for all three PHBs. As the delay of the reference flow jumps

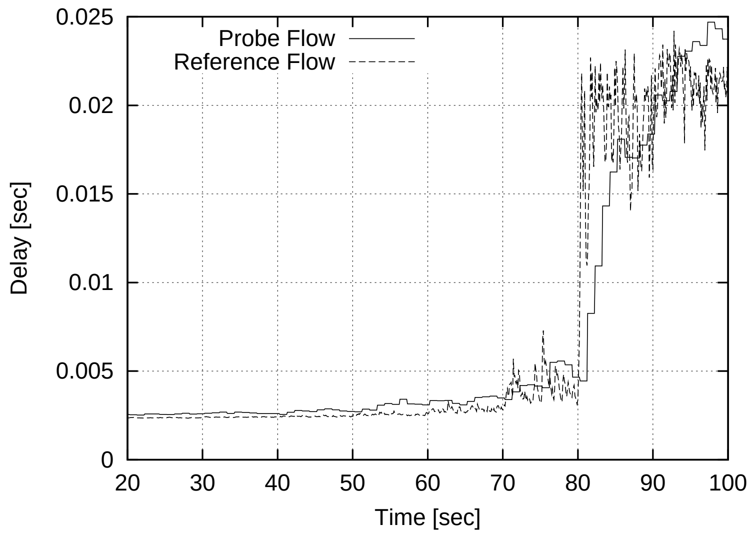

Figure 13: Delay of probe flow and of reference flow for the AF PHB

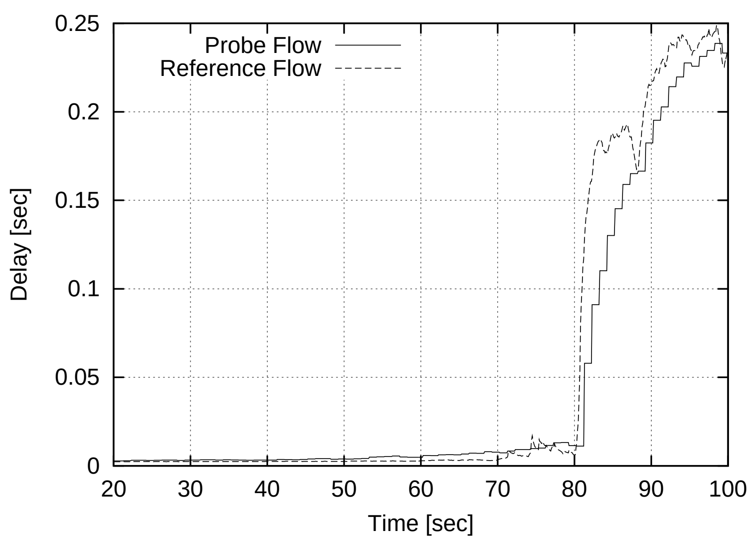

Figure 14: Delay of probe flow and of reference flow for the BE PHB

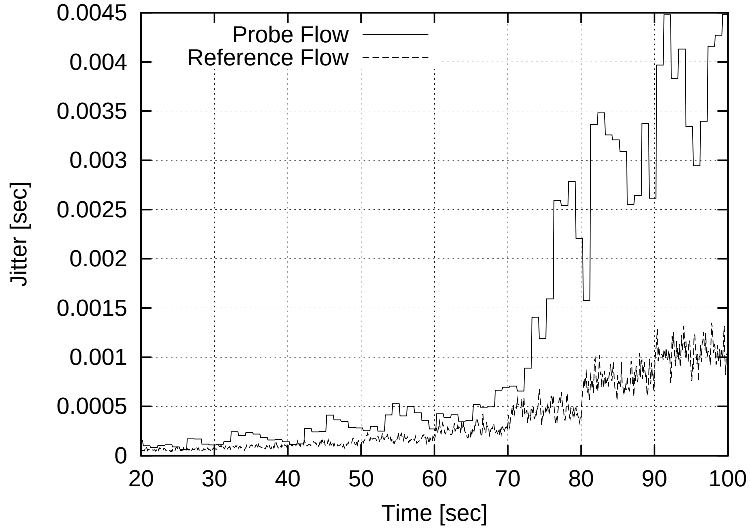

Figure 15: Jitter of probe flow and of reference flow for the EF PHB

up, the probe flow curve follows slowly. The reason for this behavior is EWMA used, which is computed on a per-packet basis. The weight for the latest measurement is higher for the probe flow (10%) than for the reference flow (2%), but the smaller number of probe packets compared to the number of reference packets results in a longer time that is needed for the EWMA value to adjust. Additionaly, the interval between the arrival of two feedback packets results in a step-shaped curve for the probe flow measurements with a step size of approximately 1000 msec.

The delay measured comprises the propagation delay, the queuing delay, and the transmission delay. Note that the transmission delay for probe packets and the transmission delay for normal data packets are generally not the same. Under the assumptions made, additional 100 bytes of packet size increase the transmission delay by 0.08 msec per link. We consider this as a negligible effect.

5.2.1.2 Jitter

In Figure 15, Figure 16, and Figure 17, we present measurement results for jitter. The jitter measurement gathered by probe packets is mostly higher than the actual jitter of the reference flow. However, a correlation between both values can be seen in all three figures. The difference is mainly due to the different inter-packet gap, which is two orders

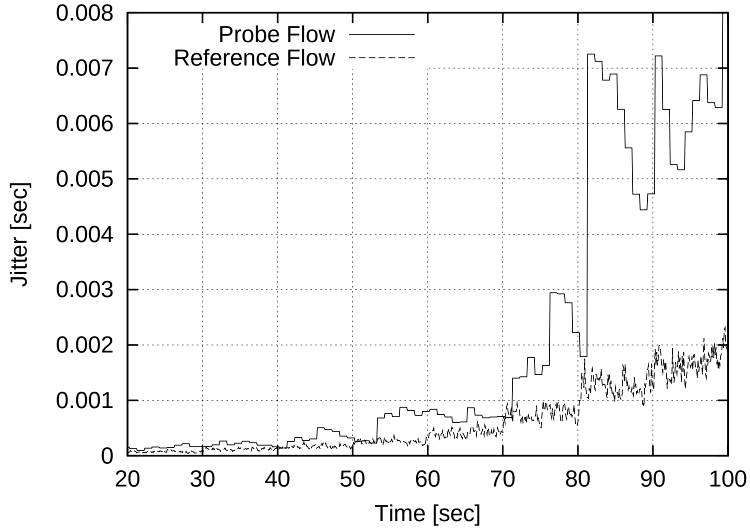

Figure 16: Jitter of probe flow and of reference flow for the AF PHB

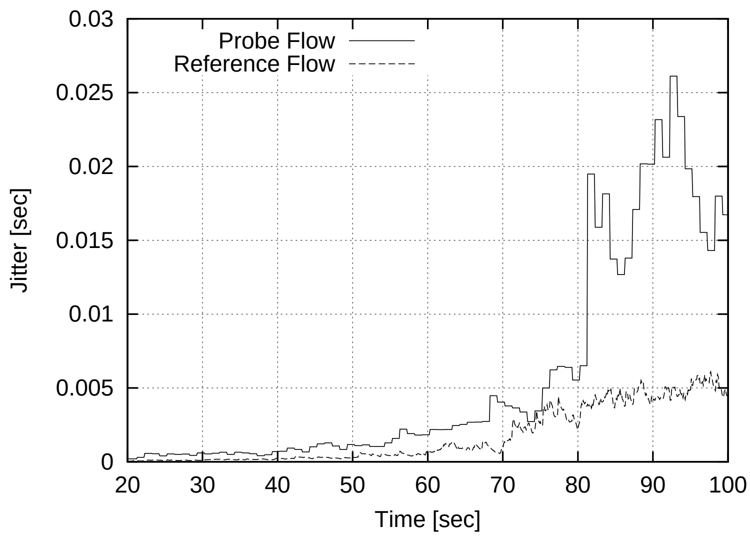

Figure 17: Jitter of probe flow and of reference flow for the BE PHB

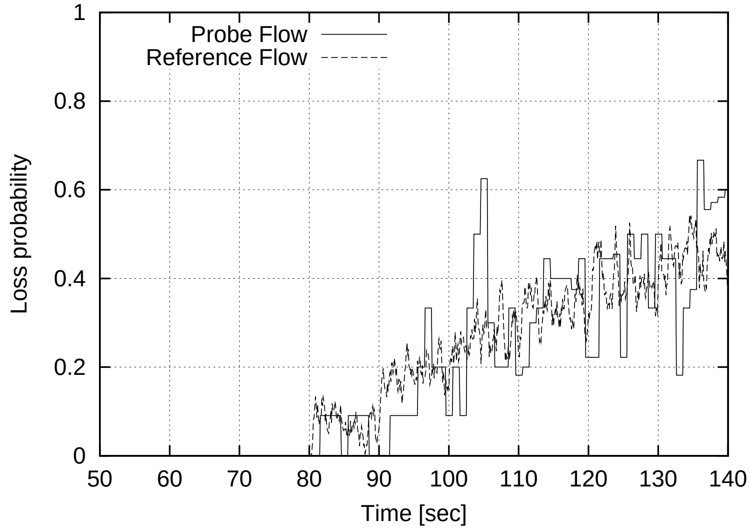

Figure 18: Loss probability of probe flow and of reference flow for the EF PHB

of magnitude higher for the probe flow than for the reference flow.

5.2.1.3 Loss

Figure 18, Figure 19, and Figure 20 show the loss probability of packets of the probe flow and the reference flow for EF, AF, and BE traffic. The probe flow drop probability is measured over a 6 second window, the reference flow drop probability uses a 0.5 second window. The probe flow gives a hint regarding the general tendency of the reference flow drop probability for the high probabilities during these simulations. The reason for inaccuracies of the probe-based measurement is mainly that the 6 second window comprises on average only 24 probe packets in the configuration used. Additionally, latencies decrease the accuracy. A drop is recorded when the next probe packet after the lost packet is received, which introduces latencies in the order of the inter-probe gap. Then, the measurements have to be sent back, which introduces additional latencies because of the 1 sec gap between feedback packets. Besides the temporal inaccuracies, the resulting measured drop probability is coarse due to the limited number of packets in the measurement window.

To investigate these accuracy problems further for lower drop probabilities, we show results for a different setup. One probe and one data flow are sent over a link with a 1% packet loss probability. There is only one traffic class, i.e. PHB. Figure 21 shows the results

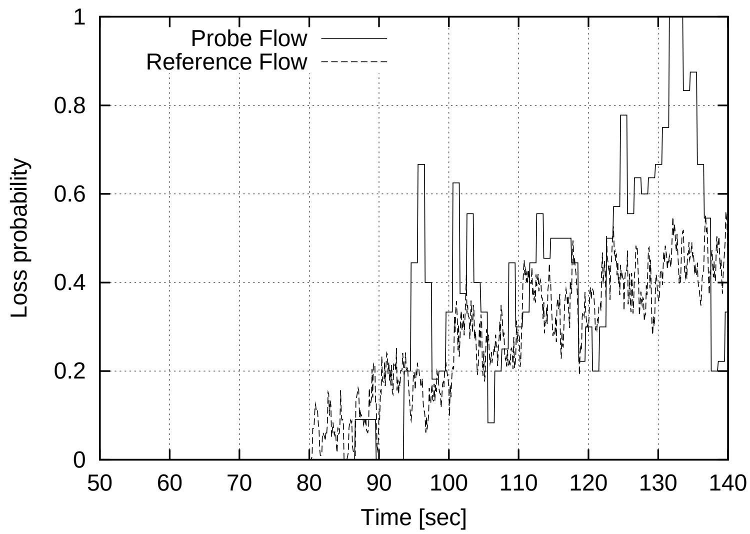

Figure 19: Loss probability of probe flow and of reference flow for the AF PHB

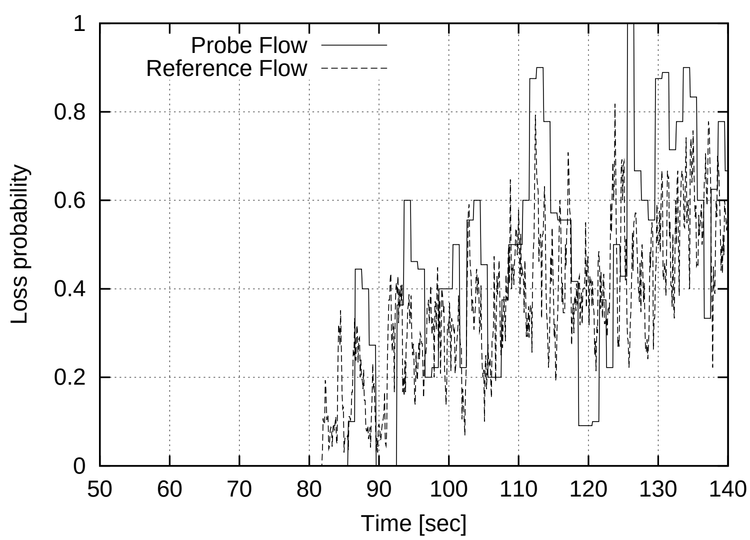

Figure 20: Loss probability of probe flow and of reference flow for the BE PHB

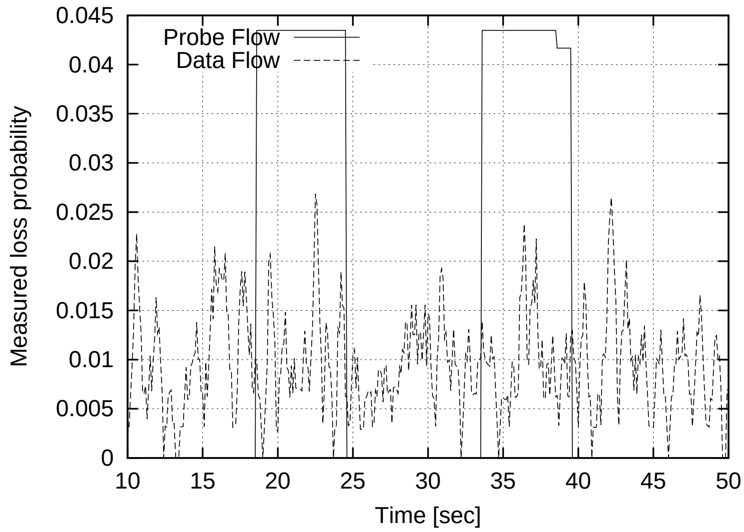

Figure 21: Loss probability of one probe flow and one data flow for a link with 1% loss probability

of the measured loss probability. Because of the limited size of the measurement window, the probe flow measurement does not reflect the link loss probability well enough.

The measurement error mainly depends on two variables: the size of the measurement window n (in packets) and the probability that a packet is dropped p. The number D of dropped packets in the window is then a random variable with a binomial distribution, i.e. the probability that d packets are dropped is given by

$$\mathrm{Prob}\{D = d\} = \binom{n}{d} p^d (1-p)^{n-d}.$$

Based on D, we can define the measured loss probability P as

$$P = \frac{D}{n}.$$

Then, the absolute measurement error is given by

$$E_{abs} = |P - p| = \left|\frac{D}{n} - p\right|$$

and the relative measurement error is given by

$$E_{rel} = \frac{|P - p|}{p} = \frac{|\frac{D}{n} - p|}{p}.$$

The expected values of E_{abs} and E_{ref} are

$$\mathrm{E}[E_{abs}] = \sum_{d=0}^{n} \left|\frac{d}{n} - p\right| \binom{n}{d} p^d (1-p)^{n-d} \tag{2}$$

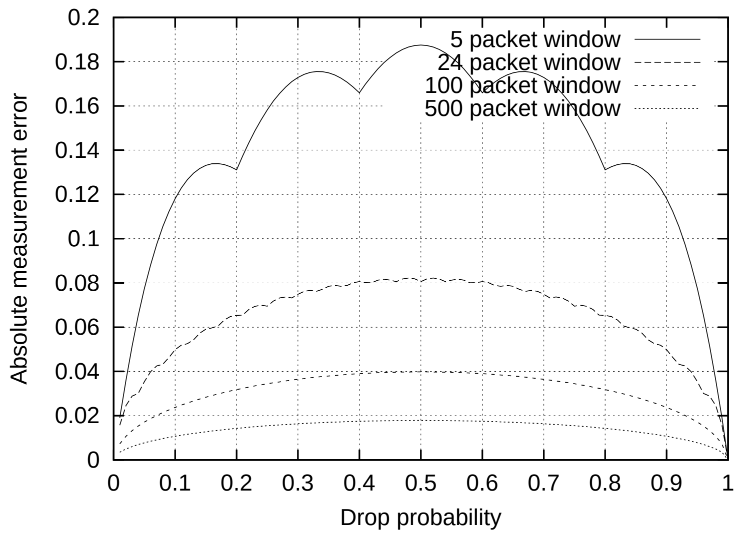

Figure 22: Expected value of the absolute error of the drop probability measurement versus actual drop probability

and

$$\mathrm{E}[E_{rel}] = \sum_{d=0}^{n} \frac{\left|\frac{d}{n} - p\right|}{p} \binom{n}{d} p^d (1-p)^{n-d}. \tag{3}$$

Figure 22 and Figure 23 show plots of (2) and (3), respectively, if the actual packet loss probability is varied for different sizes of the measurement window. The absolute error is biggest for a 0.5 loss probability and smallest for very low and very high loss probabilities. The relative error is smaller for higher loss probabilities.

The absolute and relative measurement errors for a varied measurement window size is shown in Figure 24 and Figure 25. The measurements are more precise when more packets are in the measurement window. In Figure 25, we can see that the relative error is very high even for big measurement windows if the loss probability is reasonably low.

The latter is the main problem inherent in the probe-based loss probability measurement. Low loss probabilities, which we desire to have in the network, cannot be estimated precisely enough. A better precision could be achieved in two ways. First, the rate probe packets are sent with can be increased to have more packets in the measurement window. However, this increases the intrusiveness since more bandwidth is consumed by probes. Second, the temporal interval comprising the measurement window can be increased. This worsens the dynamic properties of the estimate though.

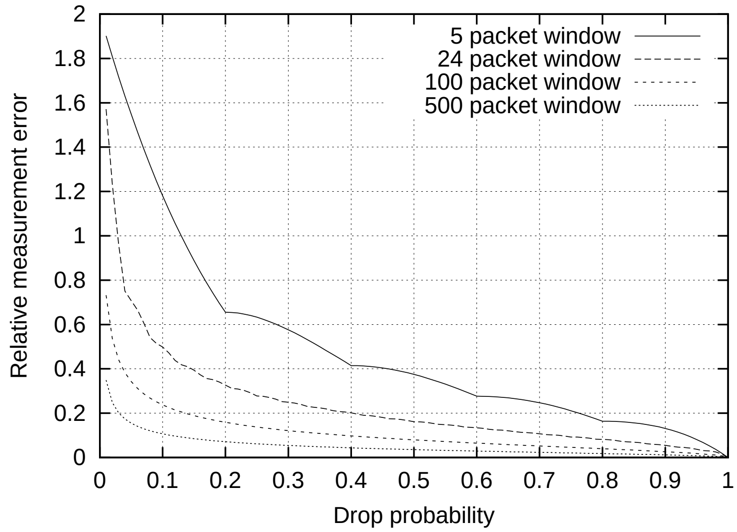

Figure 23: Expected value of the relative error of the drop probability measurement versus actual drop probability

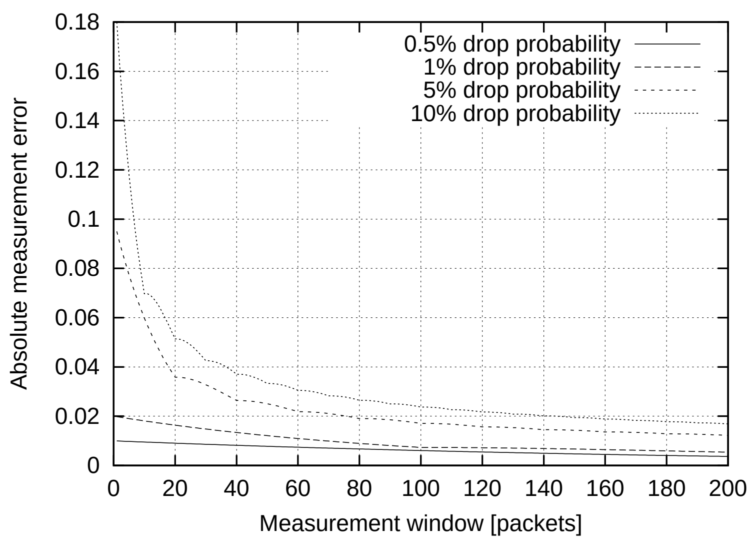

Figure 24: Expected value of the absolute error of the drop probability measurement versus measurement window size

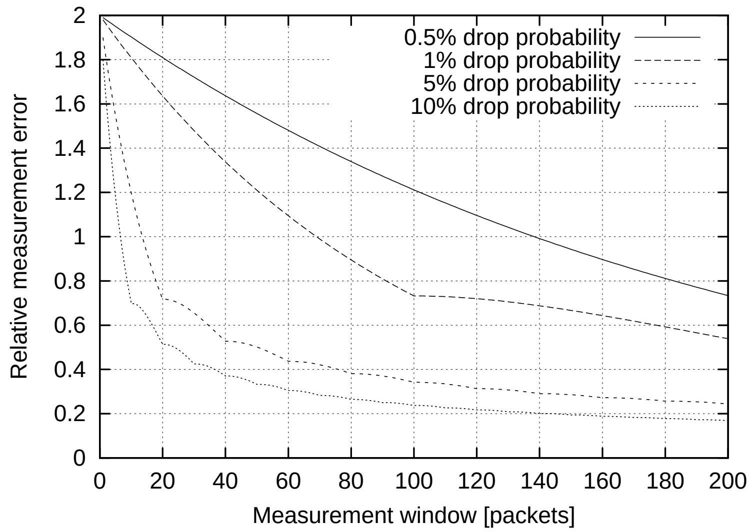

Figure 25: Expected value of the relative error of the drop probability measurement versus measurement window size

5.3 Probing and Reserving Available Bandwidth by Congesting Paths with Low-Priority Probe Packets

A valuable metric is the bandwidth that is available on an LSP. However, as discussed in Section 2.2.3, it is difficult to measure this value. Furthermore, the techniques discussed previously are all intrusive and strongly interfere with actual data traffic on the network, which is undesirable if probing has to be performed on a frequent basis since such probing consumes a significant amount of bandwidth by itself, increases queuing delay, and introduces additional jitter. This is especially a problem in our network setup comprising only 16 unidirectional links, which are traversed by 60 LSPs to be probed. With the LSP configuration used, each unidirectional link is traversed by 7 LSPs on average. Additionally, an effective algorithm should give accurate results without probing the path for a long time.

5.3.1 Using Low-Priority Packets to Probe for Available Bandwidth

As a remedy to the issues described above, we can exploit the DiffServ support the RAN has [27]. To minimize the impact of these special probe packets on normal data packets, we can set up a DiffServ codepoint with an associated per-hop behavior especially for such probes. Note that these probes differ from the ones described in Section 5.2 used for probing delay etc. The basic concept for bandwidth probing is to flood the path of interest with this new probe type containing a certain codepoint. Nodes on the path are configured to forward these probe packets only if no other packets are available. An ingress router on the rim of the traffic engineering domain sends out such probes to an egress router. The egress router measures the rate of the incoming probes and sends the result back in a feedback packet—as described in the previous section for probing delay etc.—to the ingress router. Thus, the suggested scheme only needs support on the edge of the network if we assume that all routers in the inner network are DiffServ-enabled and have support for the special probe codepoint.

If only one path is probed, the probing router can send out probe packets at a rate greater or equal to the bottleneck bandwidth of this path. The egress router then measures the complete available bandwidth on that path by computing the throughput of the probe flow. If multiple paths are probed and these paths share links, the probes compete with each other and the available bandwidth measured is lower than the actual available bandwidth. A solution to this problem would be to have edge routers sending out time-limited bursts of bandwidth probes in a way that there is nearly no overlap in the probing periods. The distribution and mean of inter-burst times has to be chosen in a way that the probability of overlapping bursts on multiple LSP sharing links is reasonably low.

Implications of these problems and further ideas exploiting the outlined interaction between probe flows are discussed later in Section 5.3.3.

5.3.2 Intrusiveness

This scheme does not guarantee zero-intrusiveness. If there are only probes queued at a router's link, the router starts to forward a probe. In the event a new data packet arrives after the transmission of a probe has started, the transmission of the probe packet is completed first (non-preemptive queuing). This is a delay problem that becomes more severe the larger the probe packets get. The minimum packet size is dictated by the underlying link layer technology.

To get an impression about the severity of the effects of the outlined bandwidth probing mechanism on actual data traffic, we obtained simulation results using our modified version

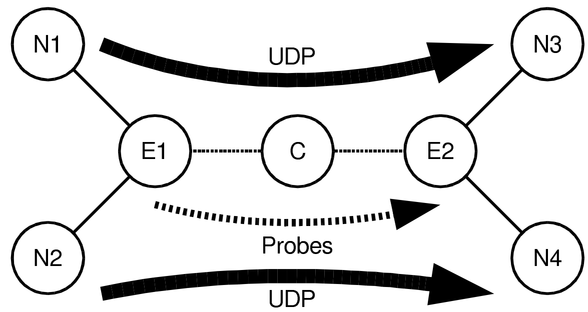

Figure 26: Topology used to measure intrusiveness

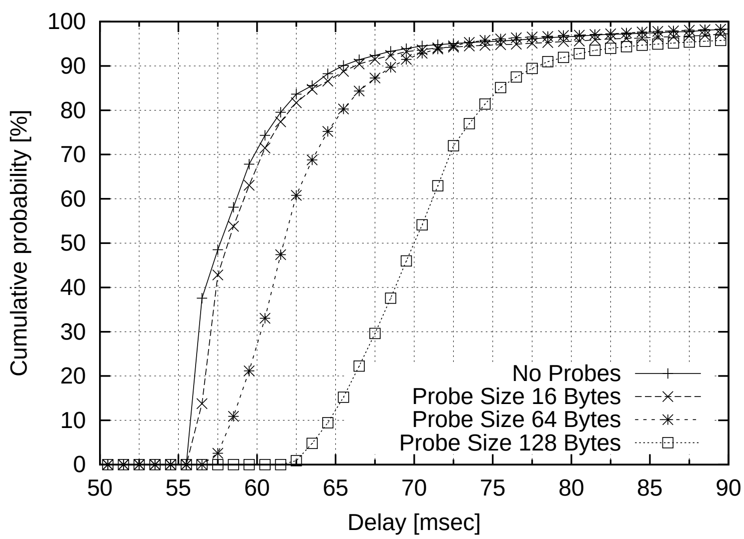

Figure 27: Delay distribution

of ns-2. We used ns-2's DiffServ module to set up an additional queue just for probes, as described above. This queue is only considered by the queue server if all the queues for the other traffic classes are empty and therefore yielding their time slot.

5.3.2.1 Topology for Simulation

For this evaluation, we assume a simple network setup as shown in Figure 26. All links have a propagation delay of 10 milliseconds and a bandwidth of 100 kbps. The latter has been chosen to limit the number of simulated events. If the link bandwidth is made larger, more probes have to be generated to fill up the additional bandwidth. The simulation of a network with 1 Gbps links can therefore take up to about 10,000 times longer. As shown in Figure 26, there are user datagram protocol (UDP) senders sending from node N1 to node N3, and from node N2 to node N4, respectively. The senders are configured such that the

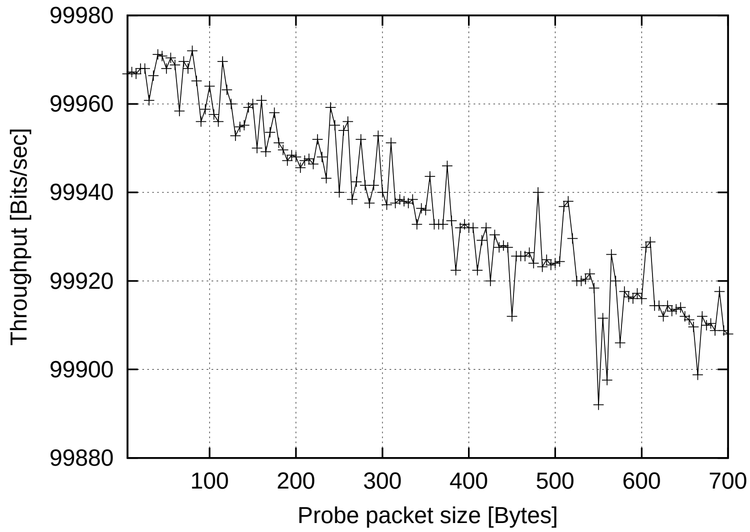

Figure 28: Overall throughput vs. probe packet size

link utilization of the DiffServ network core, the dashed links in Figure 26, is about 60%. We choose a small data packet size of 50 bytes for the UDP packets since the negative effect of probes becomes more apparent for smaller data packets. Probe packets are sent from edge router E1 on the rim of the core network to edge router E2. There is only one core router, labeled "C" in Figure 26. Probes are sent at the maximum rate, and therefore we see the worst-case effects of probes on data packets.

5.3.2.2 Effects on the Delay Distribution

In Figure 27, we present the resulting delay on data packets as a result of probe packets. The plot shows the probability that the delay of a data packet is below a certain threshold. The 16-byte probes have nearly no effect on the delay characteristics while the 128-byte probes introduce an additional delay of over 10 milliseconds. The 64-byte probes increase the delay by less than 5 milliseconds. Probes of about this size are reasonable to assume with regard to popular link-layer technologies.

5.3.2.3 Ability of Probes to Fill up Available Bandwidth

Figure 28 shows the overall throughput in the network. This is the aggregated throughput of all UDP senders plus the throughput of the probes. Furthermore, this throughput is closely related to the link utilization of the core links - the only difference is that the UDP throughput is measured on N3 and N4 rather than on E2 as it is done for the probes, which implies an additional delay because of the extra link the packets have to traverse. Since the UDP throughput is constant and, in fact, shows only little dependence on the probe packet size, the difference between the 100,000 bps link capacity and the value of the graph in Figure 28 is available bandwidth that has not been filled up with probes. Thus, this bandwidth is available but not measured. Figure 28 shows that the measurement error gets worse as probes become larger. This occurs linearly. Nevertheless, even for probe packets sized 700 bytes, the error is still small, about 90 bps compared to the link capacity of 100,000 bps.

5.3.3 Bandwidth Reservation

The fact that multiple bandwidth probe flows interfere with each other might appear to be problematic for the general case but can be exploited to assemble a distributed bandwidth reservation scheme [27, 26]. The idea is that routers do not probe for the maximum available bandwidth, they probe for the amount of additional bandwidth they anticipate to use in the near future. In the simplest case this anticipation can be based on the bandwidth the router is already using on this path. The bandwidth a router is using is defined here to mean only the bandwidth for which the router is acting as the ingress point into the core network. The traffic that the router forwards on behalf of other routers in the core network is not considered to be used by this router. The ingress router learns how much of the bandwidth it is asking for is available in the network based on the needs of other routers by a feedback packet sent to it by the endpoint of the path, the egress router. Such feedback packets containing measurement results are sent off by egress routers in fixed time intervals. This implies that every router gets a fair share of the resources of the network. A hotspot cannot completely cut off another part of the network. In this sense routers can reserve bandwidth by probing for it. Another implication is that race conditions are avoided. Consider a case in that two routers know about a certain amount of available bandwidth. Both routers admit new calls and start using a vast amount of this unused bandwidth. The network core, however, might not be able to support the traffic from both routers because of shared links on paths. In our scheme this problem is addressed. Routers just replace probes with data packets up to the rate the egress router receives the probes. In other words, routers can assume that the rate the probe flow is received with at the egress router equals an amount of reserved bandwidth. However, changing the probe rate to alter reservations introduces race conditions. We investigate this in Section 5.3.3.6 and Section 5.3.3.7.

5.3.3.1 Nomenclature and Assumptions

Probes are sent between edge routers, which we call E1 to En_{e}. The actual data is generated by nodes N1 to Nn_{n} connected to the network that is bordered by these edge routers. The remainder of the network consists of the core routers C1 to Cn_{c}. For reasons of simplicity we assume that all traffic injected into the core network by an edge router Ei is generated by node Ni. Hence, $n_{\mathrm{e}} = n_{\mathrm{n}}$. Edge router E$j$ sends probes to edge router Ek at a rate $R_{j,k}$. Note that in general there can be multiple paths connecting those routers. However, to simplify the nomenclature, we assume a single path is used when Ej is sending to Ek for this evaluation of bandwidth reservation schemes. $D_{j,k}$ denotes the data rate Nj is sending to Nk. This implies under our assumptions that this traffic has Ej as ingress point into the core network while Ek is the egress point. Furthermore, this traffic traverses the same path as the probes that Ej sends to Ek. Ek ideally measures a rate $M_{j,k}$ of probes coming in from Ej.

5.3.3.2 Replacing Probes with Data Packets

For the following, we assume a network topology with a single congestable link. In that scenario, let the overall probe rate of all edge routers probing over this single congestable link be S and the available bandwidth not being used for data traffic be A. Additionally, let $A < S$. If a fluid traffic model is used, the measured rate $M_{j,k}$ can be determined as

$$M_{j,k} = R_{j,k} \cdot \frac{A}{S}. \tag{4}$$

If Ej wants to increase its data rate $D_{j,k}$ by $Q_{j,k}$, it has to decrease its probe rate $R_{j,k}$ by $Q^{\mathrm{probe}}_{j,k} = Q_{j,k} \cdot \frac{R_{j,k}}{M_{j,k}}$ in order that other probe flows do not measure a lower rate. Before the rates change, Em measures a probe rate $M_{l,m}$ originating from El according to

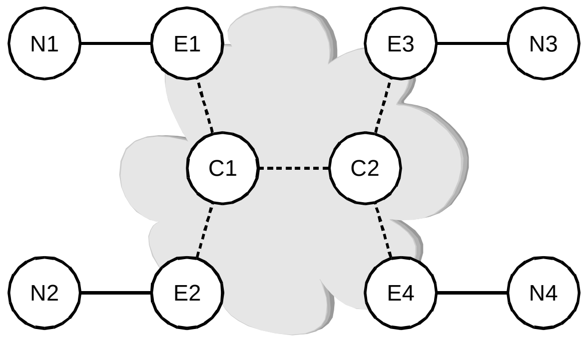

Figure 29: Topology of simulated test network

$$M_{l,m} = R_{l,m} \cdot \frac{A}{S}.$$

After the rates change, the new measured probe rate is

$$M_{l,m}^{\mathrm{new}} = R_{l,m} \cdot \frac{A - Q_{j,k}}{S - Q_{j,k}\frac{R_{j,k}}{M_{j,k}}}.$$

By using (4) to substitute $M_{j,k}$, we obtain

$$M_{l,m}^{\mathrm{new}} = R_{l,m} \cdot \frac{A - Q_{j,k}}{S - Q_{j,k}\frac{S}{A}} = R_{l,m} \cdot \frac{A}{S} = M_{l,m}.$$

Since ingress routers can be sure that the probe rate they achieve does not change, this bandwidth can be seen as reserved. Ingress router Ej can increase the rate of the data it is injecting into the core network bound for egress router Ek by up to $Q_{j,k}^{\max} = M_{j,k}$.

5.3.3.3 Accuracy of Measured Rates at Egress Routers

The calculation of the correct value the probe rate has to be decreased by relies on the exact value $M_{j,k}$. In reality, this value is measured by the egress router Ek, and the result is sent back to Ej. Obviously, the actual measured rate, which we denote as $\tilde{M}_{j,k}$, does in general differ from the theoretical value calculated in (4).

We present simulation results showing this effect for a simple topology. Figure 29 shows this topology. The cloud denotes the probing domain with the inner core routers C1/C2 and edge routers E1 to E4. Initially, the data rates are configured as $R_{1,3} = 70$ kbps, $D_{1,3} = 20$ kbps, $R_{2,3} = R_{2,4} = 5$ kbps, and $D_{2,3} = D_{2,4} = 10$ kbps. The data rate $D_{1,3}$ is varied by a value $Q_{1,3} = -20 \ldots 70$ kbps ($D_{1,3}^{\mathrm{new}} = D_{1,3} + Q_{1,3}$). Likewise, the probe rate is varied by

$Q_{j,k}^{\text{probe}} = Q_{j,k} \cdot \frac{R_{1,3}}{\tilde{M}_{1,3}}$, where $\tilde{M}_{1,3}$ is set to the correct rate of $M_{1,3} = 52.5$ kbps and to values 10% below and above this rate.

Figure 30 shows the theoretically anticipated measured rate $\tilde{M}_{2,4}$ for the probe flow from E2 to E4 depending on the rates of the data and probe flows from N1/E1 to N3/E3. Ideally, $\tilde{M}_{1,3} = 52.5$ kbps. If $D_{1,3}$ and $R_{1,3}$ are changed, then there is no effect on $\tilde{M}_{2,4}$ (flat part of the curve in Figure 30) until all probes are used up ($Q_{1,3} = 52.5$ kbps). If at this point the data rate is increased further, other flows are starved off (the curve slopes). For $D_{1,3} = 80$ kbps, there is no bottleneck bandwidth left for probes since the prioritized data traffic uses up all bandwidth.

If the measurement is 10% too low and hence $\tilde{M}_{1,3} = 47.25$ kbps, $\tilde{M}_{2,4}$ increases as more probes are replaced with data. In this erroneous measurment case, all probes are replaced for $Q_{1,3} = 47.25$ kbps. Then, other flows are starved off, and $\tilde{M}_{2,4}$ linearly decreases as $D_{1,3}$ is increased further. In the case of a 10% too high measurement ($\tilde{M}_{1,3} = 57.75$ kbps), $\tilde{M}_{2,4}$ decreases since $R_{1,3}$ is not decreased enough. When all probes are replaced ($Q_{1,3} = 57.75$ kbps), the curve again decreases linearly.

Figure 31 shows the experimental results obtained by simulation. The simulated rates are close to the mathematically estimated ones in Figure 30. Note that due to the reasons outlined in Section 5.3.2, there is still probe throughput for $D_{1,3} \geq 80$ kbps.

These results represent the effects when one flow measures an increased rate while the other flows do not measure a decreased rate. In reality, if one flow measures an increased rate other flows measure a decreased rate. Hence, these nodes assume a lower value for their reserved bandwidth anyway. There are however some unusual situations when an egress router measures an increased rate, but the other routers do not measure a decreased rate, e.g. if lots of probes are piling up in a queue near the egress router and are then transmitted in a burst.

The setup analyzed here consists of only three probe flows. Therefore, the probe throughput degradation experienced by the flows on paths for which the data rate is not increased is more severe than in a situation where there are lots of other flows. Hence, we conclude that there is no significant effect of measurement errors on bandwidth reservation in general.

5.3.3.4 Variable Bit Rate Traffic

The bandwidth reservation mechanism assumes that once the probe rate is reduced, data is sent at a constant bit rate (CBR). In general, the traffic characteristics of many applications show a variable bit rate (VBR).

VBR issues for the probing framework presented in [8] are examined in [9] (see Section 2.2.2). An important observation in the latter paper is that one cannot use the average rate to reduce the VBR to a CBR case. If multiple VBR sources peak, the network becomes overloaded. Instead, the peak data rate of flows has to be considered. Figure 32 shows two VBR data flows sharing bandwidth. Although the sum of both average rates is in general lower than the total bandwidth available, the network is overloaded between t_1 and t_2.

In [9], it is proposed to use a sufficiently long probing phase to measure all VBR characteristics before a call is admitted. In contrast to [8], the probing scheme in this research continuously probes the network rather than using probing phases and data phases for distinct calls. Hence, VBR traffic can be addressed by applying a filter function on the measured probe rate at the egress router.

Another solution is to monitor the data rate. If this rate drops, the ingress router can fall back to probes again. The latter has the disadvantage that there is no clear instantaneous rate. Rates are always averaged over a certain amount of time. Therefore, it is hard to decide when the data rate drops.

5.3.3.5 Multiple Bottlenecks

The fluid traffic model used to calculate the rate Q^{probe} that probing has to decreased by assumes a single bottleneck. In Figure 33, we show a probing scenario over multiple bottlenecks with the corresponding nomenclature. On link 0, probes are sent with a rate R_0. Due to cross traffic (denoted by a gray arrow) on link 1, the total probing rate is S_1, and the free bandwidth that can be used by probes is A_1. Because of these constraints, core router C1 forwards probes at a decreased rate of $R_1 = R_0 \cdot \frac{A_1}{S_1}$. Probes are dropped at a rate of $R_1^d = R_0 - R_1$ at C1. A similar situation occurs on the next link, link 2. The probe

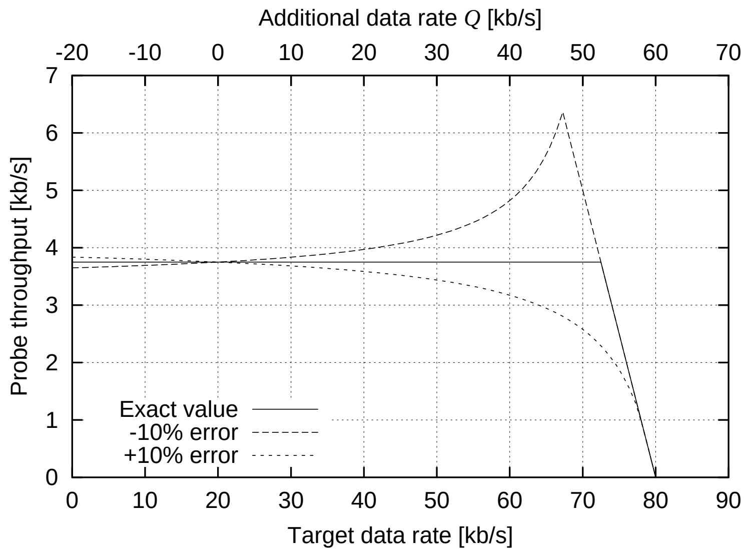

Figure 30: Theoretically anticipated rate $\tilde{M}_{2,4}$

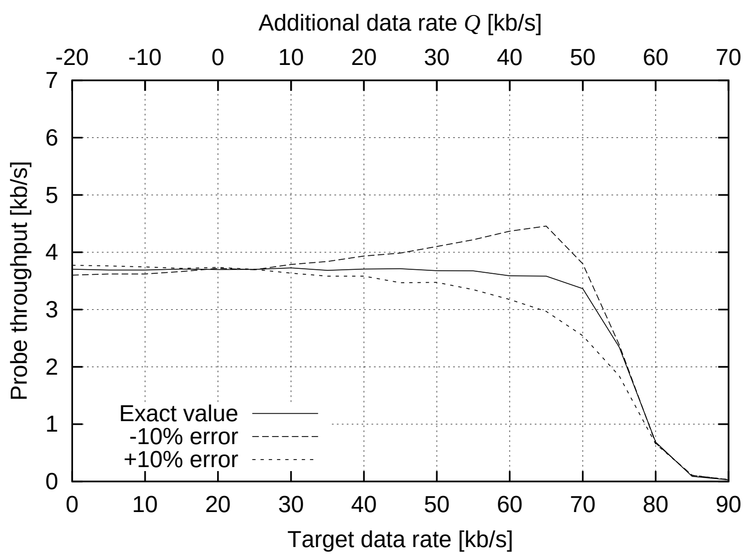

Figure 31: Simulated results for $\tilde{M}_{2,4}$

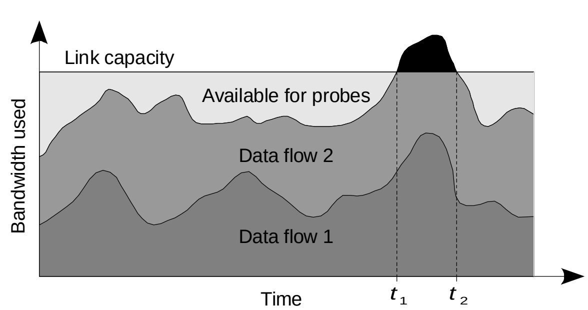

Figure 32: Example bandwidth utilization for two data flows

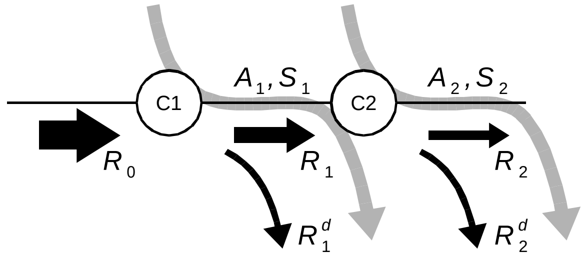

Figure 33: Probing through multiple bottlenecks

drop rate is $R_2^d = R_1 - R_2$ while probes are forwarded by C2 with a rate $R_2 = R_1 \cdot \frac{A_2}{S_2}$. The available bandwidth for probes on this link is A_2, the overall probe rate is S_2. Both link 1 and link 2 are congested. Hence,

$$R_0 > R_1 > R_2. \tag{5}$$

Eventually, R_2 is measured at an egress router as the rate M_0 corresponding to the original rate R_0. Based on this, Q^{probe} is calculated as

$$Q^{\text{probe}} = Q \cdot \frac{R_0}{M_0} = Q \cdot \frac{R_0}{R_2} = Q \cdot \frac{S_1 S_2}{A_1 A_2}. \tag{6}$$

Note that S_1 and S_2 depend on R_1 and on R_2, respectively, since S_i denotes the sum of all probe rates on link i.

However, Q^{probe} is based on a single bottleneck assumption and hence is not the correct rate. This value of Q^{probe} does not assure that other flows are not affected. Additionally, every link would require a different value for Q^{probe} so that other flows do not measure altered rates. For link 1, this value is

$$Q_1^{\text{probe}} = Q \cdot \frac{R_0}{R_1}. \tag{7}$$

For link 2 we get

$$Q_2^{\text{probe}} = Q \cdot \frac{R_1}{R_2}. \tag{8}$$

By using (5), we can conclude from (6), (7), and (8) that

$$Q^{\text{probe}} = Q \cdot \frac{R_0}{R_2} > Q \cdot \frac{R_0}{R_1} = Q_1^{\text{probe}}$$

and

$$Q^{\text{probe}} = Q \cdot \frac{R_0}{R_2} > Q \cdot \frac{R_1}{R_2} = Q_2^{\text{probe}}.$$

This argument still holds in the general case of more than two bottlenecks.

Therefore, if a single bottleneck is assumed to calculate Q^{probe}, but there are multiple bottlenecks present in the network, the ingress router will back off its probe rate more than actually necessary. In other words, it has more bandwidth available than measured. The effect on other probe flows is that they measure that more bandwidth is reserved for them after the rates have been changed by the ingress router of interest. This is not severe since every ingress router can still assume that the amount of bandwidth reported by a corresponding egress router is still available. More precisely, in a multiple bottleneck setup ingress routers can assume that *at least* the bandwidth reported to them is available.

In addition to the properties probe flows have under the mechanisms introduced so far, a scheme is needed that allows nodes to change their reservations. Two such schemes are briefly outlined in the following sections.

5.3.3.6 Uncooperative Scheme for Reserving Bandwidth

The first scheme requires nearly no cooperation between edge routers. With respect to probing, two distinct cases of link loads are relevant. First, all data rates plus all probe rates are less or equal than the link capacity C. This implies that $A \geq S$. Second, all data rates are less than C, but all data rates plus all probe rates are more than C. Therefore, $A < S$. Figure 34 shows these values for a single link partially used by data and probe traffic.

If $A \geq S$, ideally no probe is dropped. Probes can be dropped occasionally because of packet bursts temporarily overloading a queue. Hence, $M_{j,k} = R_{j,k}$. Let B denote the bandwidth completely unused. Then an ingress router can increase its data rate $D_{j,k}$ by $Q_{j,k}$ without decreasing its probe rate $R_{j,k}$ as long as $Q_{j,k} \leq B$. In general, if multiple ingress routers increase their data rates, the sum of these increases has to be less or equal B (assuming one congestable link). The same holds for increasing the probe rate. However, B is not known by the ingress routers. Routers can determine whether B is exceeded by observing if the measured rate $M_{j,k}$ is smaller than $R_{j,k}$. Since the actual measured rate $\tilde{M}_{j,k}$ is in general slightly inaccurate, the routers should determine whether B is exceeded

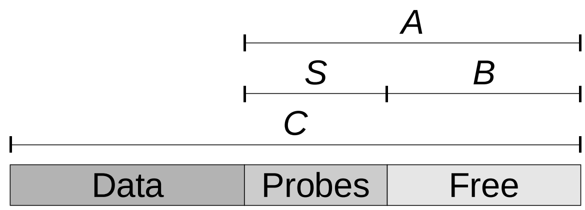

Figure 34: Rates and capacities

with the help of a tolerance factor α. Hence, B is exceeded if $\tilde{M}_{j,k} < \alpha \cdot R_{j,k}$. Since multiple routers can increase their rates at the same time and exceed B, the measured probe rate can drop spontaneously leading to less reserved bandwidth. Therefore, if B is assumed not to be exceeded, routers take care for this effect by only claiming a fraction β of this rate as reserved. The assumed reserved bandwidth for Ej sending to Ek is $\min\{\tilde{M}_{j,k},\ \beta \cdot R_{j,k}\}$. Eventually, all capacity will be used, and when routers increase their data rate, they decrease their probe rate according to Section 5.3.3.2.

5.3.3.7 Cooperative Scheme for Reserving Bandwidth

The second scheme assumes that edge routers cooperate with respect to reservations although it sticks with the paradigm that no direct signaling (besides feedback packets) is exchanged among edge routers. For reasons of simplicity, we assume a single congestable link. In this setup, ingress routers can be sure that the probe rate received at the egress router is constant in the long run although there can be instantaneous fluctuations that are due to VBR traffic. Moreover, if we drop the single congestable link assumption, the probe rate can only be increased in the long run while it will never be decreased. Therefore, an edge router can increase its rates in a way that other routers receive probes at a decreased rate. These routers then assume that the decreased rate is due to such an immoderate rate increase of another edge router. Likewise, they still assume that the bandwidth reserved is the probe rate received previously. Additionally, if this decreased rate is received for a certain amount of time t_d, it is interpreted as a request to withdraw some of the reserved bandwidth because it is needed by another edge router. The decrease has to be big enough such that edge routers can distinguish it from bursts induced by VBR traffic. For the edge router Ej probing to Ek, a way to achieve the rate decrease other edge routers measure is to increase its own probe rate by $P_{j,k}$. Then other edge routers e.g. probing from El to Em will not measure the normal rate of

$$M_{l,m} = R_{l,m} \cdot \frac{A}{S}.$$

They measure a decreased rate of

$$M_{l,m}^{\text{new,P}} = R_{l,m} \cdot \frac{A}{S + P_{j,k}}.$$

Since probes are dropped on their way through the network, the rate of $P_{j,k}$ remaining can become too small to have an impact on $M^{\text{new,P}}$. A remedy to this is the use of a privileged probe type. These privileged probes have a higher priority than regular probes but a lower priority than data packets. By default, edge routers send no privileged probes. If a decrease of other probe flows is required from Ej to Ek, edge router Ej sends out these privileged probes at a rate $H_{j,k}$ to Ek. This has basically an effect on A. Finally, other edge routers measure

$$M_{l,m}^{\text{new,P,H}} = R_{l,m} \cdot \frac{A - H_{j,k}}{S + P_{j,k}}.$$

Let us turn back to the probe rates from Ej to Ek, still assuming a single bottleneck. Basically, we can distinguish four steps. First, the normal rate probes are received at is given by

$$M_{j,k} = R_{j,k} \cdot \frac{A}{S}. \tag{9}$$

Then Ej increases $R_{j,k}$ by $P_{j,k}$. The received probe rate changes to

$$M_{j,k}^{\text{new,P}} = (R_{j,k} + P_{j,k}) \cdot \frac{A}{S + P_{j,k}}. \tag{10}$$

By using (9) and (10), we can estimate A as

$$A = \frac{M_{j,k} M_{j,k}^{\text{new,P}} P_{j,k}}{M_{j,k} R_{j,k} + M_{j,k} P_{j,k} - R_{j,k} M_{j,k}^{\text{new,P}}}.$$

Based on this we choose a value $H_{j,k} < A$. Third, we send out privileged probes at this rate. The rate received is

$$M_{j,k}^{\text{new,P,H}} = (R_{j,k} + P_{j,k}) \cdot \frac{A - H_{j,k}}{S + P_{j,k}}.$$

Eventually, other nodes will back off and release parts of the bandwidth they reserved. This amount is denoted by T. The rate received after this step is

$$M_{j,k}^{\text{new,P,H,T}} = (R_{j,k} + P_{j,k}) \cdot \frac{A - H_{j,k}}{S - T + P_{j,k}}.$$

T can now be estimated as

$$T = \frac{(M_{j,k}P_{j,k} + R_{j,k}H_{j,k})(M_{j,k}^{\text{new,P,H}} - M_{j,k}^{\text{new,P,H,T}})}{M_{j,k}^{\text{new,P,H,T}}(M_{j,k} - M_{j,k}^{\text{new,P,H}})}. \tag{11}$$

This amount of bandwidth can then be reserved by Ej by setting the new probe rate to $R_{j,k}^{\text{new}} = R_{j,k} + T$. However, this analysis only works for single bottlenecks. In a multiple bottleneck setup, T cannot be estimated using (11).

5.3.4 Conclusions

Even though the available bandwidth measurement scheme outlined in the previous section has some promising properties, we decided in a final evaluation that it is to costly to deploy in the radio access network setup we investigated. Especially the lack of a lean reservation scheme for *multiple* bottlenecks lead to this decision. However, without the reservation part, the scheme becomes problematic because multiple flows interfere with each other, and without knowledge about the kind of this interference (like the number and rates of all probe flows competing for bandwidth), the gathered information is not valuable enough.

5.4 Using Medium and Low Priority Probes for Bandwidth Reservation and Discovery

To address the deficiencies of the probing and reservation scheme outlined in the previous section, we designed a leaner scheme based on two types of bandwidth probes: discovery probes (DP) and reservation probes (RP). DPs are used to discover parts of the available bandwidth on a path, and RPs are used to reserve this bandwidth.

5.4.1 Queuing of Data Packets, Reservation Probes, and Discovery Probes

On each node in the network, incoming packets are demultiplexed according to their DiffServ codepoint (DSCP). This is depicted by a demultiplexer (demux) in Figure 35. The DSCP determines the queue into that packets are sorted. Data packets with EF/AF/BE PHBs

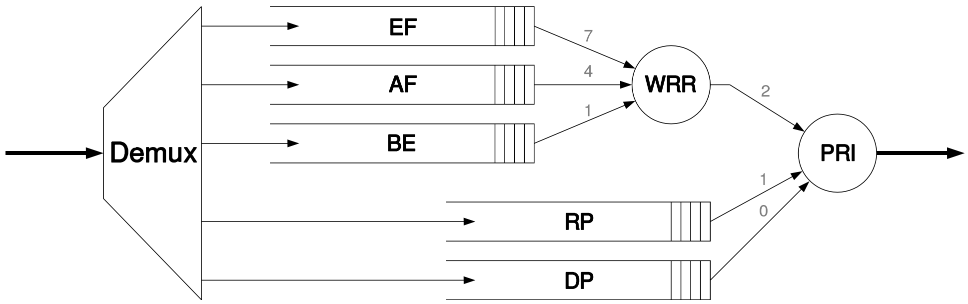

Figure 35: Node queuing architecture for RP/DP scheme

are sorted into three different queues as previously indicated in Section 3.2. These queues are serviced in a weighted round robin (WRR) fashion. The WRR queue server services the EF queue with weight 7, the AF queue with weight 4, and the BE queue with weight 1. The data packets then pass through a second stage with a second queue server, which uses a priority (PRI) queuing scheme. Data packets have the highest priority of 2. In case there is no data packet to be dequeued, the queue with the next lower priority, 1, is considered. This queue contains all RPs. If there is no RP to dequeue, a DP is dequeued from the last queue with priority 0. If this queue is also empty, the outgoing link stays idle until a packet becomes available.

5.4.2 Discovering Bandwidth

Each pair of ERs sends DPs on every path with a fixed rate of R^{DP}. For example, ERj sends DPs with a rate of $R^{\mathrm{DP}}_{j,k} = R^{\mathrm{DP}}$ to ERk.[1] ERk measures the rate these DPs are received with, denoted $\tilde{M}^{\mathrm{DP}}_{j,k}$ and reports it back to ERj in a feedback packet. Depending on whether there is enough bandwidth on each link of a path to accommodate all DPs, $\tilde{M}^{\mathrm{DP}}_{j,k}$ is either close to R^{DP} or lower. If there is not enough bandwidth on a link for all DPs, DPs are dropped. The available bandwidth on that link is then shared among the DP flows, in the ideal case similar to (4). However, ERj can assume that bandwidth amounting to at least $\tilde{M}^{\mathrm{DP}}_{j,k}$ is available.

[1] For the sake of a brief nomenclature, we drop the path index as explained before in Section 5.3.3.1.

5.4.3 Reserving Bandwidth

Similar to DPs, ERs send out RPs. For RPs, the rate is not fixed but corresponds to the actual reservation. ERj sends out RPs at a rate $R^{\mathrm{RP}}_{j,k}$, and Ej reports back its measurement, $\tilde{M}^{\mathrm{RP}}_{j,k}$. To make a reservation, ERj increases $R^{\mathrm{RP}}_{j,k}$ by a value of $Q^{\mathrm{RP}} \leq \tilde{M}^{\mathrm{DP}}_{j,k}$. Since $\tilde{M}^{\mathrm{DP}}_{j,k}$ is only a part of the available bandwidth resulting from the competition of multiple DP flows, this scheme guarantees that even if all ERs simultaneously try to increase their reservation there is enough available bandwidth for all RP flows.

5.4.4 Using Reserved Bandwidth

Since ideally RP flows do not have to compete for bandwidth (like the probes introduced in Section 5.3), claiming a reservation is straightforward. To increase the use of bandwidth for data flows by Q^{data}, the ER decreases its RP rate by Q^{data}. Once the data connection commences and the RP rate is decreased, this reservation is lost, i.e. after termination of the data connection, the ER does not get back its reserved bandwidth.

5.4.5 Adjusting the Amount of Reserved Bandwidth

Figure 36 shows a flowchart of the algorithm used to adjust the current amount of reserved bandwidth, i.e. the rate of RPs, R^{RP}. This algorithm runs on every edge router for every LSP. It is invoked each time reserved bandwidth is used for sending data on a path. Additionally, it is invoked in regular intervals.

First, it is checked whether reservations are blocked. Such blocking can result from certain changes of R^{RP} by the algorithm. If reservations are not blocked, the algorithm proceeds. Otherwise, no changes are made and the algorithm exits.

Next, it is checked if the measured DP throughput $\tilde{M}^{\mathrm{DP}}$ falls below a minimum threshold $M^{\mathrm{DP}}_{\mathrm{min}}$. If that is the case, then it is deduced that too many reservations are made, and the reservation R^{RP} is decreased by a factor $f_{\mathrm{decr},1}$. Furthermore, other changes of the RP rate than the one outlined in Section 5.4.5 are blocked for a duration of t_{block}.

After this, the expected bandwidth demand d is calculated. This is explained in detail in Section 5.4.6. In case the demand undershoots the minimum demand parameter d_{min}, d

Table 3: Parameters of the reservation scheme

Parameter	Default value	Description
R^{DP}	700 kbps	Fixed DP rate
$M^{\mathrm{DP}}_{\mathrm{min}}$	1000 bps	Minimum allowed DP throughput rate before node decreases RP rate
d_{min}	150 kbps	Minimal assumed demand
$f_{\mathrm{decr},1}$	0.9	Factor to back off RP rate if DP throughput is too low
$f_{\mathrm{decr},2}$	0.5	Maximal factor to decrease RP rate if RP exceeds demand
t_{block}	1.2 sec	Duration of blocking interval

is changed to d_{min}. This is to assure that even a non-utilized path can accept at least one new incoming connection request.

If the current reservation R^{RP} is lower than the demand d, R^{RP} is increased to fit the demand. However, R^{RP} is never increased by more than the measured DP rate $\tilde{M}^{\mathrm{DP}}$. Afterwards, changes of the reservation other than claiming reserved bandwidth are blocked for an interval of length t_{block} as described previously.

The current reservation R^{RP} is decreased in case it is higher than the demand d. In general, R^{RP} is changed to fit the demand, but it is never decreased below $f_{\mathrm{decr},2} \cdot R^{\mathrm{RP}}$ where $f_{\mathrm{decr},2}$ is the maximum decrease factor.

The parameters mentioned above, their default values, and a brief description of their functions are listed in Table 3.

5.4.6 Calculation of the Path Bandwidth Demand

The implemented path bandwidth demand estimation works in a very straightforward manner. Every time a connection request from ERj to ERk is issued, ERj adds the requested bandwidth and the time of the request to a list associated with the LSP that fits all requirements (besides the bandwidth needs) best. The estimated bandwidth demand per LSP is than calculated as 1.4 times the amount of bandwidth in the LSP's list during the last 2 seconds. The factor 1.4 is chosen to have a few bandwidth reserves available on each LSP.

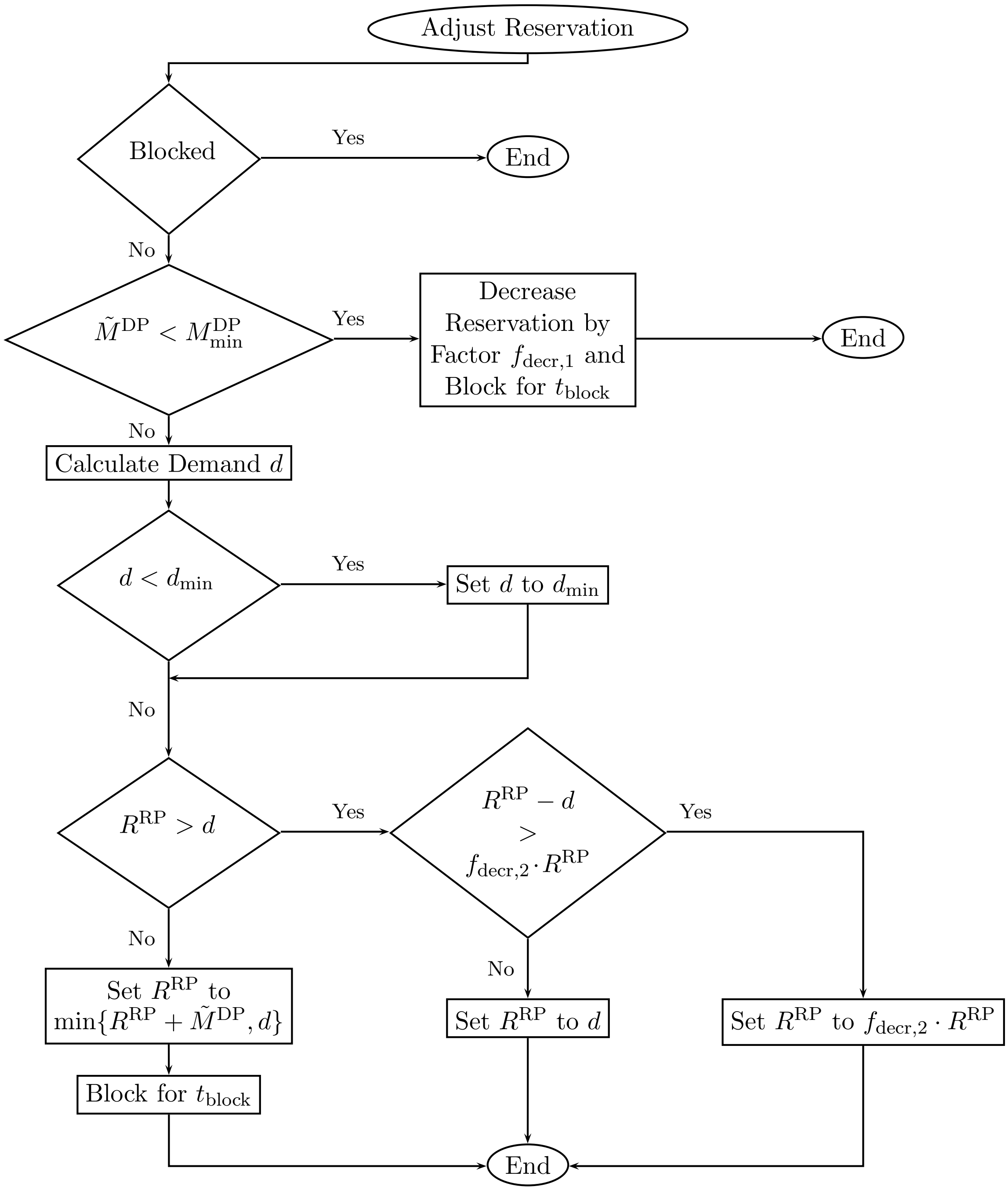

Figure 36: Flowchart of algorithm to adjust RP rate

A refined algorithm can address issues like mobility estimation and known properties of the demand (e.g. an increased demand during certain hours of the day).

5.4.7 Discussion

5.4.7.1 Scalability

Since RPs correspond to reservations, they do not impose a problem. DPs, however, are sent on every path with a fixed rate of R^{DP}, even on paths without big reservation needs. R^{DP} has to be chosen such that nodes are able to reserve enough bandwidth to accommodate as many of the connection requests occurring during the blocking period as possible. On the other hand, if a vast number of lowly utilized paths use up all bandwidth with their DPs, paths with higher demand cannot reserve enough bandwidths.

In our setup, this is not problematic, since an average number of seven LSPs sharing a link is still reasonable. Moreover, due to the small size of the assumed network, all paths are reasonably utilized in general. But in bigger networks this property can become an issue. A possible solution is to make the DP rate adaptive as well.

5.4.7.2 Importance and Actual Function of RP Packets

The sole purpose of RPs is to use up bandwidth before the actual data traffic starts for that the reservation has been made. In other words, RPs are used to indirectly signal that bandwidth is not available anymore by squeezing out DPs. Furthermore, for medium to high connection arrival rates, the RP rate set is used up for data traffic long before it can have an impact on the measured DP rate. Since in this scenario at the same time many connections end, this does not pose a problem to the scheme.

5.5 Connection Admission and Path Selection

First, all candidate paths are examined. If a path does not fulfill all criteria for the requested traffic class, it is pruned from the set of candidate paths. Then, the best path is picked from the remaining ones.

For EF, the probed delay must not exceed 26 msec and the considered path is not allowed to be penalized for recent probe losses. Moreover, 1.25 times of the requested bandwidth must be reserved. Reservations are achieved by using the scheme outlined in Section 5.4. For AF, the considered path is not allowed to be penalized for probe losses, and the bandwidth requested must be reserved. For BE, only the requested bandwidth must be reserved.

For EF, the path with the lowest delay is picked; for AF, the path with the lowest loss penalty value is picked; and for BE, again the path with the lowest delay is picked. If there is no path remaining in the set of candidate paths, the connection request is rejected.

For bidirectional traffic classes (see Section 3.2) both the forward and the reverse path are evaluated.

CHAPTER 6

PERFORMANCE EVALUATION

6.1 Overview

The following results are gathered by simulating the outlined network system for 150 seconds after a 60 second initialization and warm-up period. Per-simulation results are averaged over 4 simulator runs. The plots show the sample means and the confidence intervals for 95% confidence. Per-packet results are shown per one simulator run since the results are already smoothed out because of the large amount of packets per simulation.

We compare three different algorithms: the path queue state-based algorithm (PQS) as described in Chapter 4, the probe packet-based algorithm (PP) as outlined in Chapter 5, and shortest path first routing (SPF). The latter does not use any CAC and admits all connection requests to the network. However, if a call cannot maintain the minimum QoS requirements as described in Section 3.2, it is terminated. Therefore, all calls maintain the minimum QoS as long as they are active. We use this property as a baseline to evaluate our algorithms.

6.2 Connection Admission Control

6.2.1 Admitted Traffic for Different Connection Request Inter-Arrival Times

Figure 37 shows the number of admitted EF connection requests for each of the three algorithms. Note the reversed x-axis with high inter-arrival times corresponding to a low load on the left side. Figure 38 shows the same data for AF traffic. Since SPF uses no CAC, the number of accepted connection requests in this scheme reflects the total number of requests. The number of requests accepted by PP and PQS stays moderately constant even though the number is increased for medium inter-arrival times around 0.06 seconds. PQS is able to follow the actual demand very closely as long as the network is lowly loaded (i.e. for high inter-arrival times). PP is more conservative in this interval and blocks some

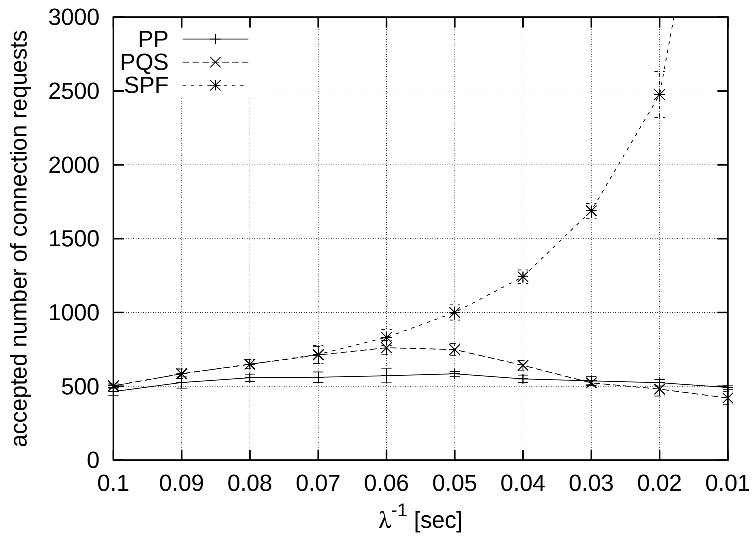

Figure 37: Number of accepted EF connection requests for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

requests, but its results are more constant over the whole scale.

The number of admitted BE connection requests is shown in Figure 39. Because of the low QoS requirements of BE traffic, an increasing number of connection requests results in more admitted connections. However, as can be seen in Figure 37 and Figure 38, this does not negatively affect the number of admitted EF and AF connections.

6.2.2 Network Utilization

In this section, we investigate the network utilization with respect to the delivered data to evaluate the overall efficiency. Since every time a path other than the shortest path (or one of the shortest paths in case multiple paths have similar hop counts) connecting two ERs is used additional resources are used in the network, we also evaluate the impact of these longer paths on efficiency.

We show results for SPF, PQS, and PP. The two latter schemes use their standard path setups with three disjoint paths between each pair of ERs. Paths other than the shortest path are penalized e.g. by the additional queuing delay imposed by an additional hop. We also show results for a non-standard path set comprising only the minimum hop (MH) paths between each pair of ERs. The results for these schemes are denoted PP/MH for PP with minimum hop paths and PQS/MH for PQS with minimum hop paths. Note that SPF in

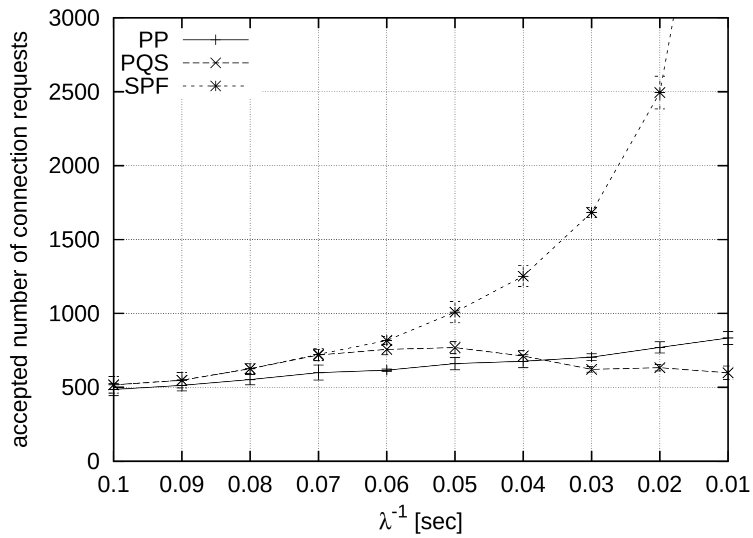

Figure 38: Number of accepted AF connection requests for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

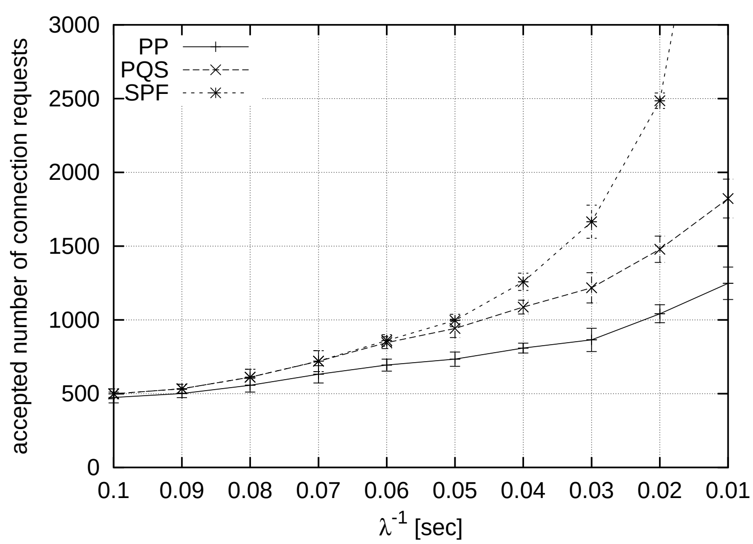

Figure 39: Number of accepted BE connection requests for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

the scope of this research denotes a scheme without CAC using only one of multiple possible shortest paths.

6.2.2.1 Evenly Distributed Traffic Load

The following results are based on a traffic load with $p_{\mathrm{EGW}} = 0.5$ and $p_{\mathrm{ER0}} = 0.3$ (see Section 3.2 for a definition of these parameters). In Figure 40, we compare the number of delivered data packets of PP, PQS, and SPF. The SPF curve shows that the network is saturated for about 8.5 million data packets. PP and PQS can deliver up to a million data packets. PQS follows the SPF closely until it saturates while PP shows poorer results for low arrival rates.

In Figure 41, we show the impact of a MH path set on the PP results. Shorter paths use less resources, so the number of delivered packets is increased. The figure shows that the saturation value for PP/MH is about in between SPF and PP. The gap between PP/MH and SPF is mainly due to the stronger QoS PP/MH guarantees. Figure 42 shows the results for PQS/MH. The trend is similar to the PP/MH results.

In Figure 43, we present the average link utilization in the network for PP, PQS, and SPF. PP always highly utilizes the links. This due to the continuous DP transmission between ERs. For PQS and SPF, the utilization ramps up with an increasing load. PQS results generally in a higher utilization since more link resources are used whenever a non-MH path is used.

For PP/MH, the average link utilization is closer to the SPF utilization (Figure 44). The MH algorithms set up 28 LSPs throughout the network while the standard path sets used by PP and PQS use 60 LSPs. Hence, the DP load on the network is smaller.

Figure 45 shows the link utilizations of PQS, SPF, and PQS/MH. PQS and PQS/MH have higher utilizations for low connection requests arrival rates.

As a metric for the efficiency, we use the number of delivered data packets divided by the average link utilization. Figure 46 shows this metric for PP, PQS, and SPF. For SPF, the ratio is nearly constant for all connection request arrival rates. PP performs poorly for low arrival rates due to the RP/DP overhead. PQS performs equally well as SPF for low

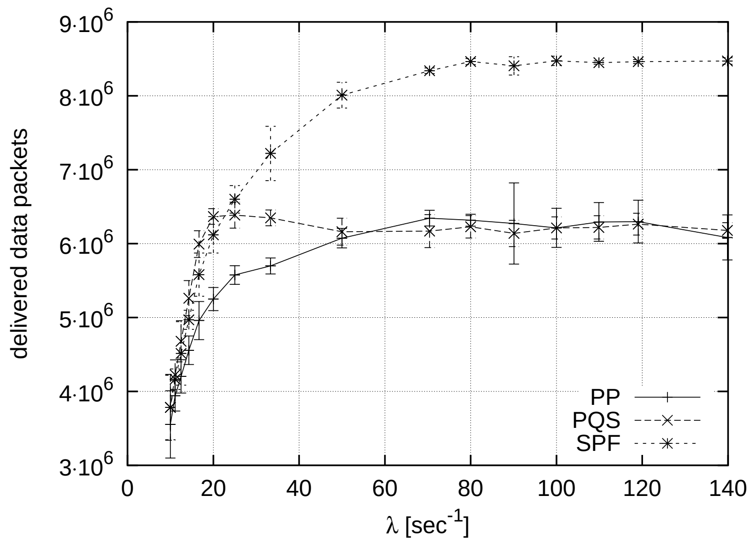

Figure 40: Number of delivered data packets for parameters $p_{\text{ER0}} = 0.3$ and $p_{\text{EGW}} = 0.5$ in the PP, PQS, and SPF schemes

rates and approaches the PP results for higher rates.

Figure 47 compares PP, SPF, and PP/MH. For medium to high rates, the PP/MH scheme outperforms PP. A similar behavior can be observed for PQS and PQS/MH (Figure 48).

6.2.2.2 Hotspot Traffic Load

We choose $p_{\text{EGW}} = 0.9$ and $p_{\text{ER0}} = 0.8$ to put a hotspot load onto the network. Figure 49 compares the number of delivered data packets for all algorithms. For medium to high arrival rates, PQS/MH delivers nearly as much packets as SPF but is additionally able to guarantee QoS for its admitted connections. All other algorithms (PP, PQS, and PP/MH) perform worse, but the gap is smaller than in the evenly distributed traffic load scenario. For medium arrival rates, PQS gets close to the performance of PQS/MH.

When comparing PQS to PQS/MH, PQS performs better for low connection request arrival rates. In this setup, an actual hotspot load occurs on the link between ER0 and the EGW. Other links can be used to transmit traffic between ER0 and the EGW on non-MH paths. As the arrival rate increases, PQS/MH performs better. For higher rates, most connection requests occur still at ER0 and the EGW, but the absolute number of requests at other nodes is not negligible anymore. The result is a higher utilization of all links in

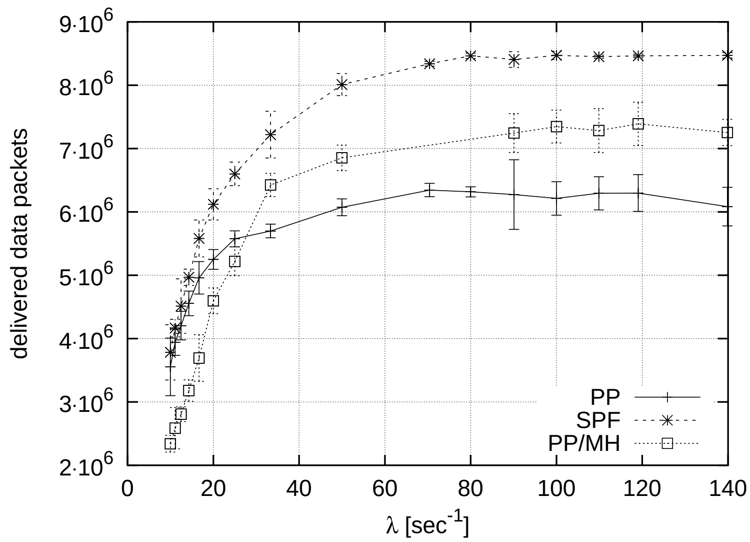

Figure 41: Number of delivered data packets for parameters $p_{\text{ER0}} = 0.3$ and $p_{\text{EGW}} = 0.5$ in the PP, SPF, and PP/MH schemes

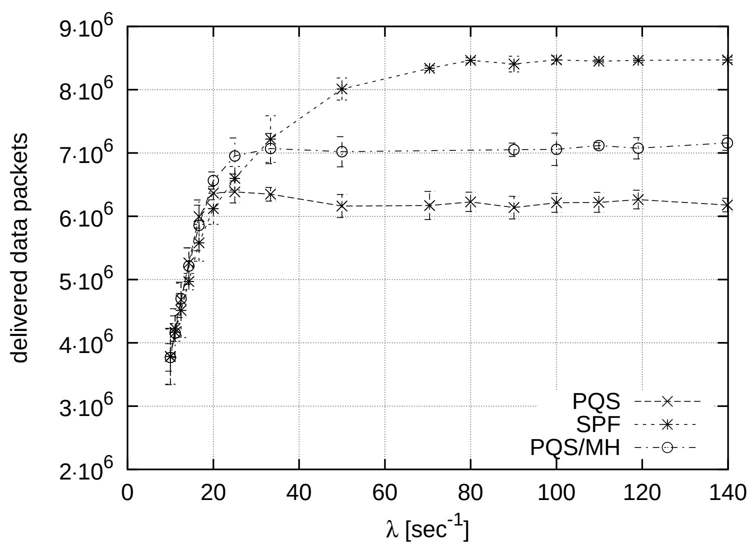

Figure 42: Number of delivered data packets for parameters $p_{\text{ER0}} = 0.3$ and $p_{\text{EGW}} = 0.5$ in the PQS, SPF, and PQS/MH schemes

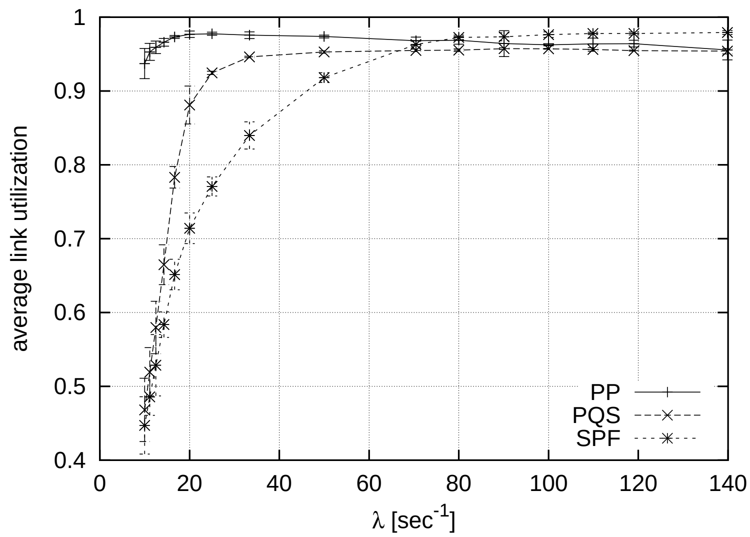

Figure 43: Average link utilization for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$ in the PP, PQS, and SPF schemes

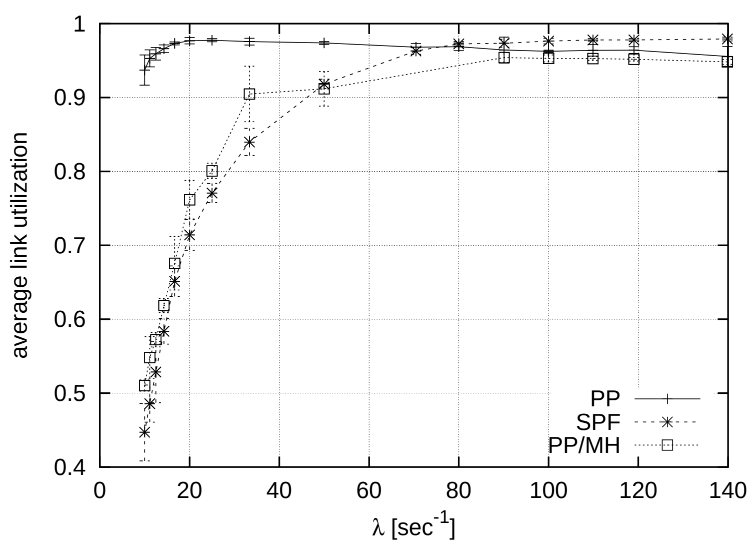

Figure 44: Average link utilization for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$ in the PP, SPF, and PP/MH schemes

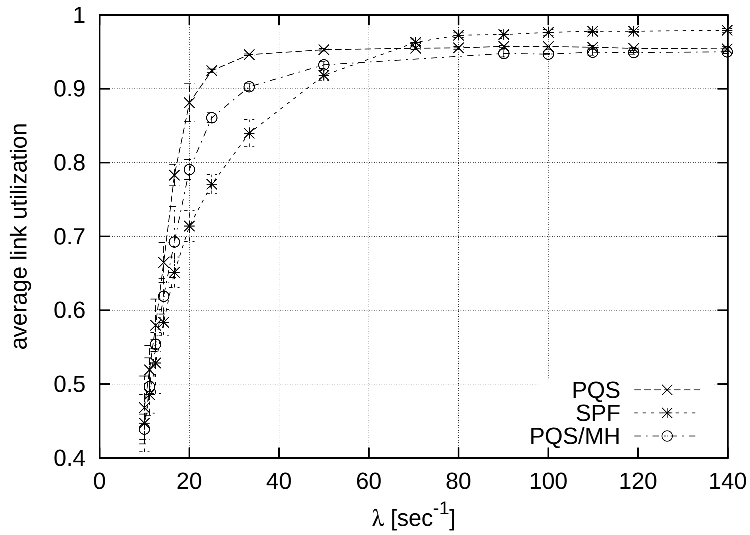

Figure 45: Average link utilization for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$ in the PQS, SPF, and PQS/MH schemes

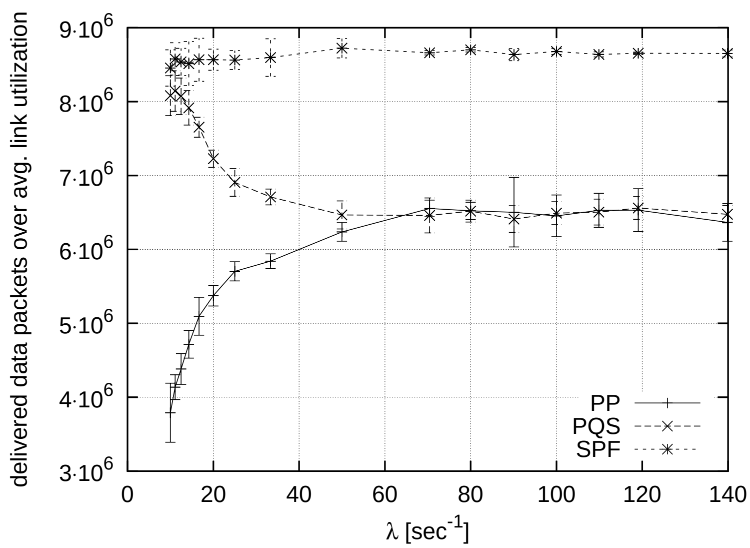

Figure 46: Number of delivered data packets over average link utilization for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$ in the PP, PQS, and SPF schemes

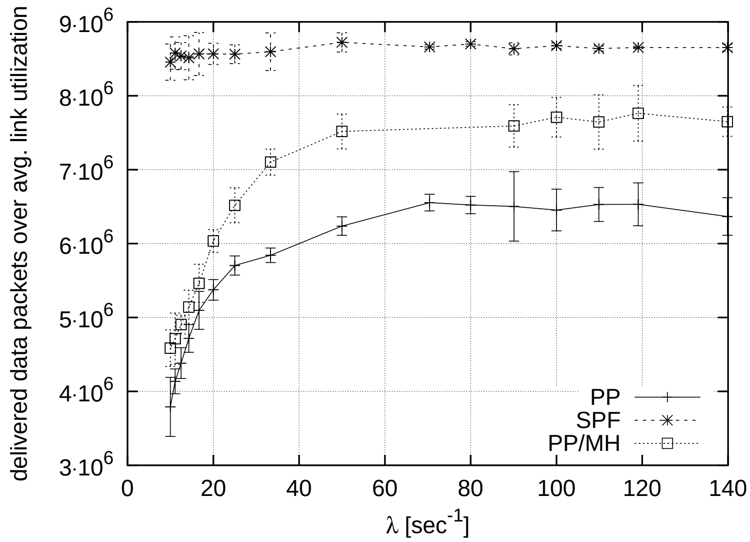

Figure 47: Number of delivered data packets over average link utilization for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$ in the PP, SPF, and PP/MH schemes

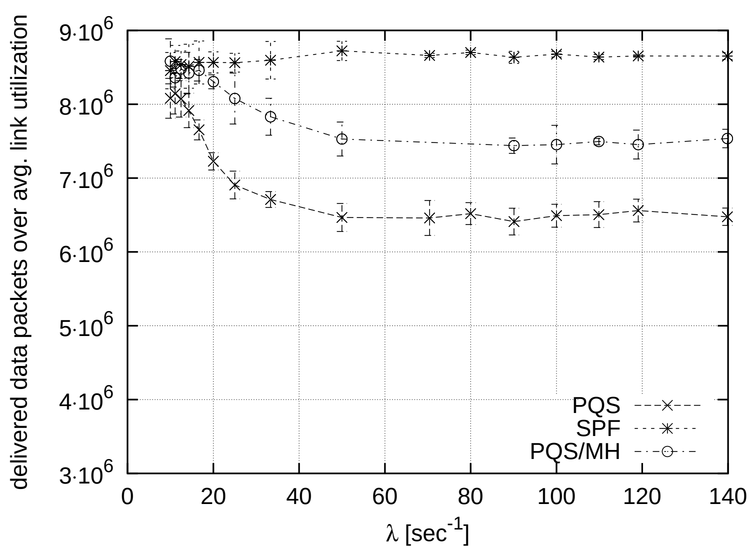

Figure 48: Number of delivered data packets over average link utilization for parameters $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$ in the PQS, SPF, and PQS/MH schemes

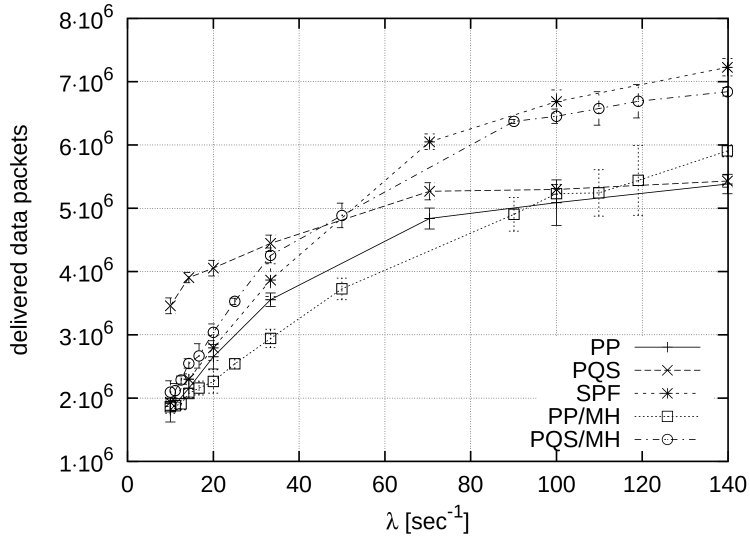

Figure 49: Number of delivered data packets for parameters $p_{\mathrm{ER0}} = 0.8$ and $p_{\mathrm{EGW}} = 0.9$ in the PP, PQS, SPF, PP/MH, and PQS/MH schemes

the network such that the non-MH paths between ER0 and the EGW have less remaining capacity. This favors a MH path set. A similar behavior can be seen for PP and PP/MH.

In Figure 50, we show the ratio of delivered data packets to the average link utilization for all algorithms. SPF is most efficient followed by PQS/MH as the first algorithm able to guarantee connections a certain QoS. It follows PP/MH, which outperforms PQS for medium to high arrival rates. For low arrival rates, the order of the latter two is reversed due to the RP/DP overhead. PP is the least efficient algorithm under this metric.

6.2.3 Effectiveness

6.2.3.1 Successful Connections

In Figure 51 and Figure 52, we present the percentage of successful EF and AF connections, respectively. The CAC-less SPF approach is not able to guarantee a high percentage of successful connections while both PP and PQS are able to achieve this goal. However, a few EF connections especially in the PQS scheme had to be terminated due to a too low QoS (Figure 51) for medium inter-arrival times.

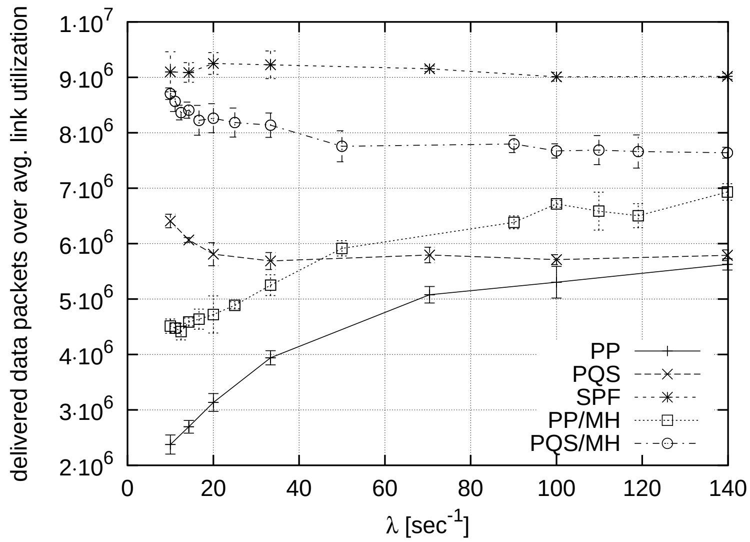

Figure 50: Number of delivered data packets over average link utilization for parameters $p_{\mathrm{ER0}} = 0.8$ and $p_{\mathrm{EGW}} = 0.9$ in the PP, PQS, SPF, PP/MH, and PQS/MH schemes

6.2.3.2 Total Aggregated Time of Successful Connections

The aggregated time of successful connections is depicted for EF in Figure 53 and for AF in Figure 54. This value is the total time of all connections as long as they are in their QoS specification. For EF, a slight peak can again be noticed for medium inter-arrival times. PQS carries the most connections in this interval, and PP has over nearly the whole simulated scale the shortest aggregated time. For AF, PQS performs best for medium inter-arrival times as can be deduced by the higher aggregated time. PP performs better for low inter-arrival times (high load). However, the SPF results show that there is still room for additional connections.

6.2.3.3 PQS Problems for Medium Connection Arrival Rates

As we could see in Figure 51 and Figure 52, the PQS scheme has some problems regarding connection admission for medium inter-arrival times. To give a better idea under which circumstances this can occur, we show the percentage of failed EF connections in Figure 55 for inter-arrival times $\lambda^{-1} = 50$ msec. Especially for $p_{\mathrm{EGW}} = 0.5$ and $p_{\mathrm{ER0}} = 0.5$, more than one out of ten admitted connections fails. PQS seems to deal well with hotspot loads (p_{EGW} or p_{ER0} high) but has trouble with more evenly distributed loads in this scenario. Figure

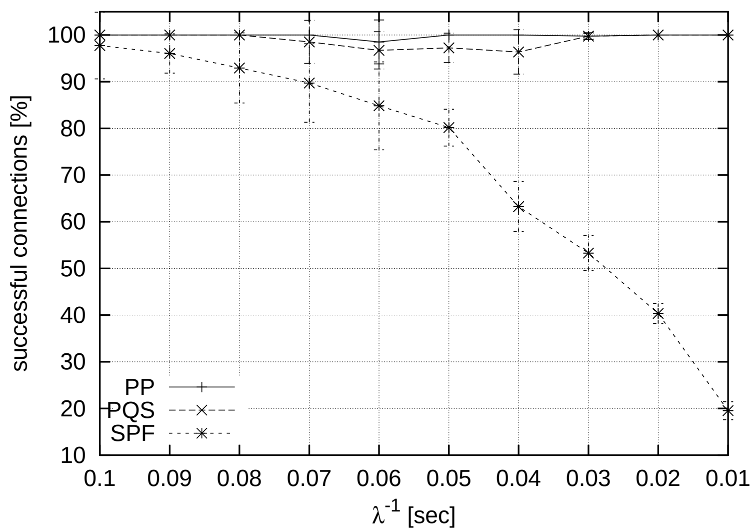

Figure 51: Percentage of successful EF connections for $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

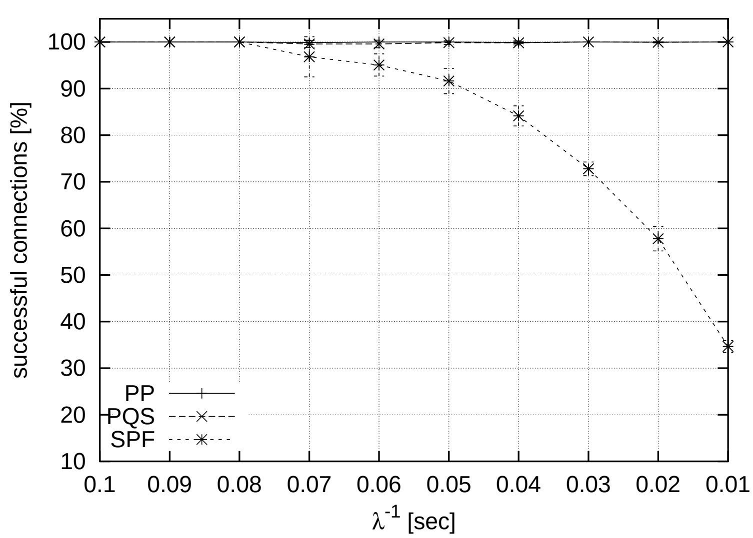

Figure 52: Percentage of successful AF connections for $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

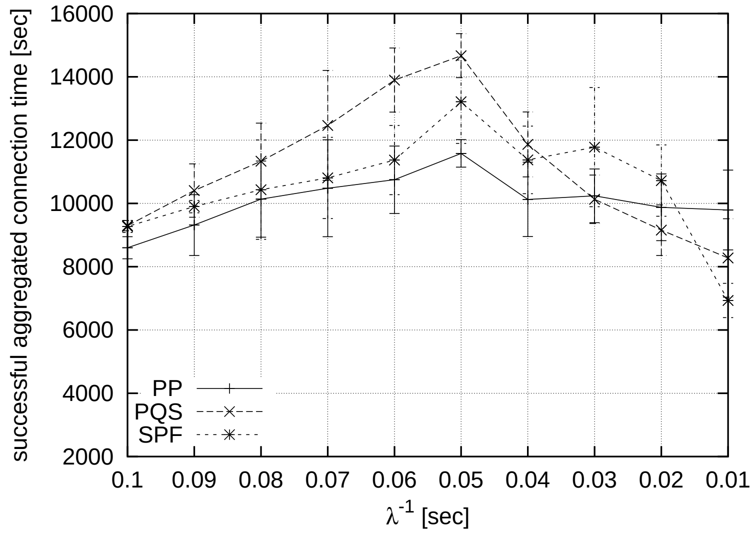

Figure 53: Aggregated time of all successful EF connections for $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

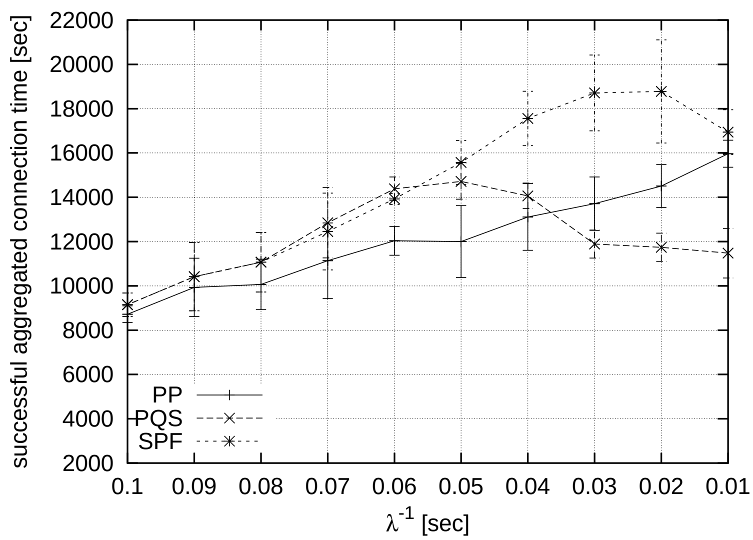

Figure 54: Aggregated time of all successful AF connections for $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

56 shows the same results for a higher loaded network with connection request inter-arrival times of 30 msec on average. In this scenario, PQS performs well, and the percentage of failed connections is reasonably small.

Figure 52 illustrates the percentage of failed AF connections in the PQS scheme. The values are an order of magnitude smaller than the ones for EF connections and therefore still acceptable.

For exact numbers on admitted connections requests and failed connections, please refer to Appendix B.

6.2.3.4 Alternative Traffic Mix

In this section, we show some CAC results for an alternative traffic mix. This alternative mix consists of 40% *ef-udp*, 0% *af-udp*, 40% *af-tcp*, and 20% *be-tcp* traffic. Figure 58 shows the percentage of successful connections in the EF class. The overall performance is worse, but for PP it is still reasonable. PQS fails especially for medium inter-arrival times. This is due to the queue service rate assumptions PQS makes. For a very low load (high connection request inter-arrival times) and a very high load (low inter-arrival times), both PP and PQS work. The SPF results are similar to the ones for the original traffic mix.

Figure 59 shows the corresponding AF results. The performance for PP and PQS is worse than for the original traffic mix, but both algorithms give acceptable results. The SPF results are again similar to the results seen for the original traffic mix.

6.2.4 Reasons for Pruning Candidate Paths

Every time a connection request is evaluated by an ER, the CAC evaluates each candidate path to check whether all admission criteria are fulfilled. Whenever a path is pruned, the reasons for this decision is logged. Since multiple criteria may not be met, one pruning can result in up to three logged reasons: one for bandwidth, one for delay, and one for detected packet drops on a path.

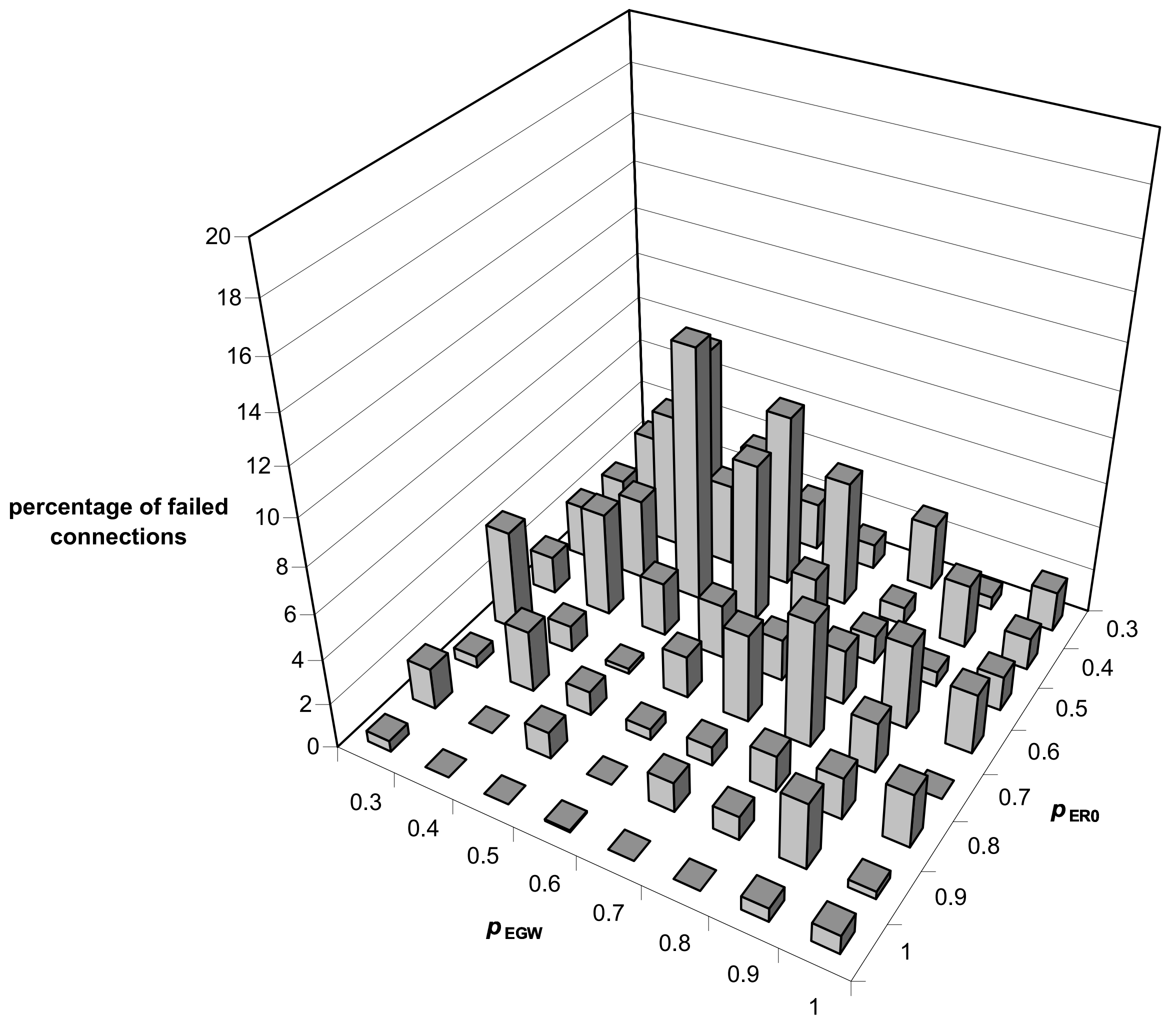

Figure 55: Percentage of failed EF connections for the PQS scheme with an inter-arrival time of $\lambda^{-1} = 50$ msec

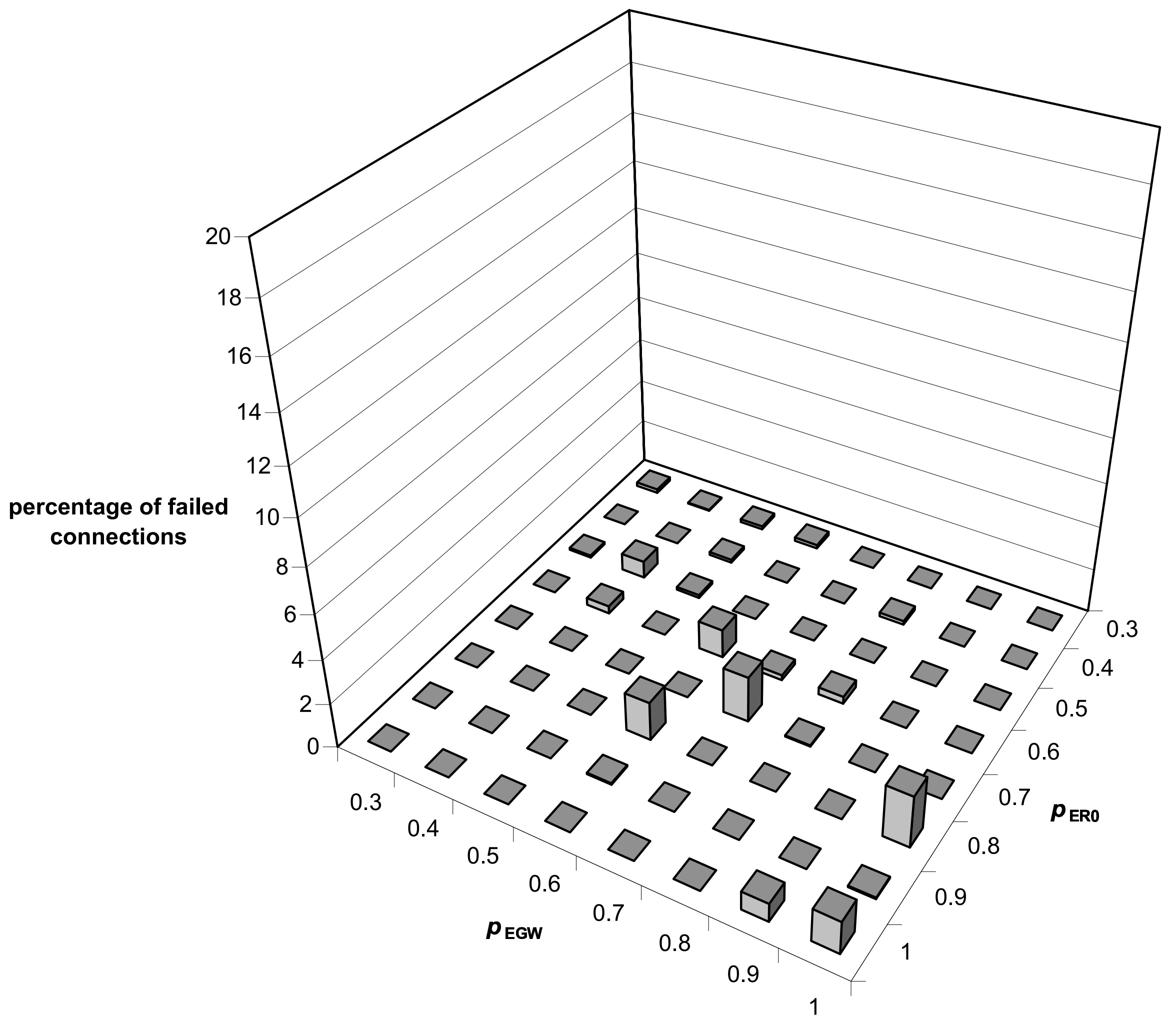

Figure 56: Percentage of failed EF connections for the PQS scheme with an inter-arrival time of $\lambda^{-1} = 30$ msec

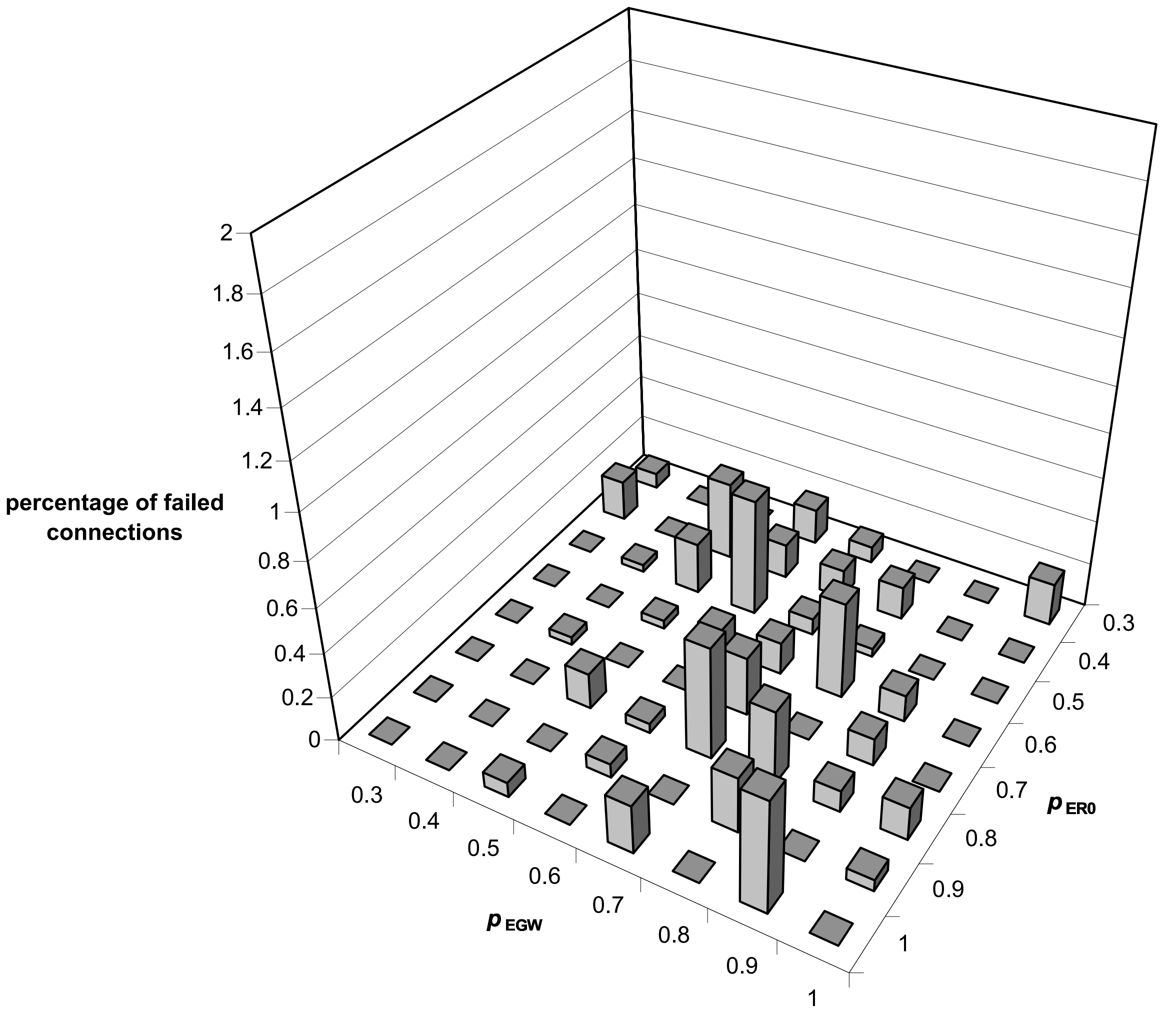

Figure 57: Percentage of failed AF connections for the PQS scheme with an inter-arrival time of $\lambda^{-1} = 50$ msec

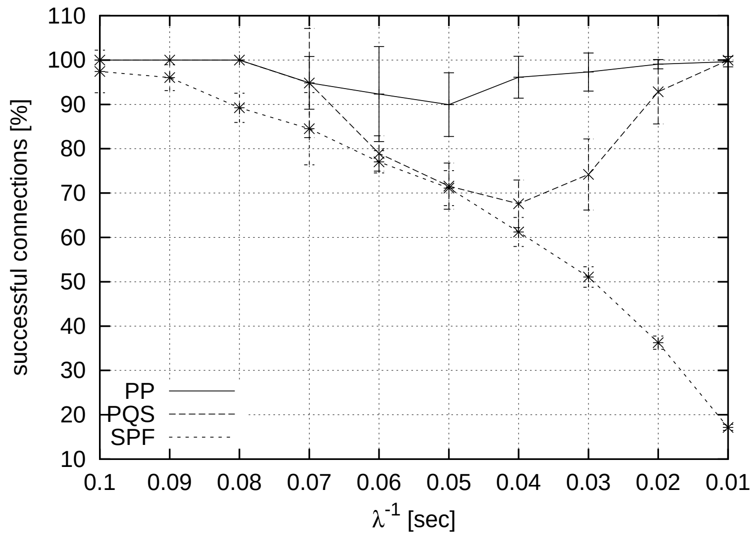

Figure 58: Percentage of successful EF connections for $p_{\mathrm{ER0}} = 0.3$, $p_{\mathrm{EGW}} = 0.5$, and an alternative traffic mix

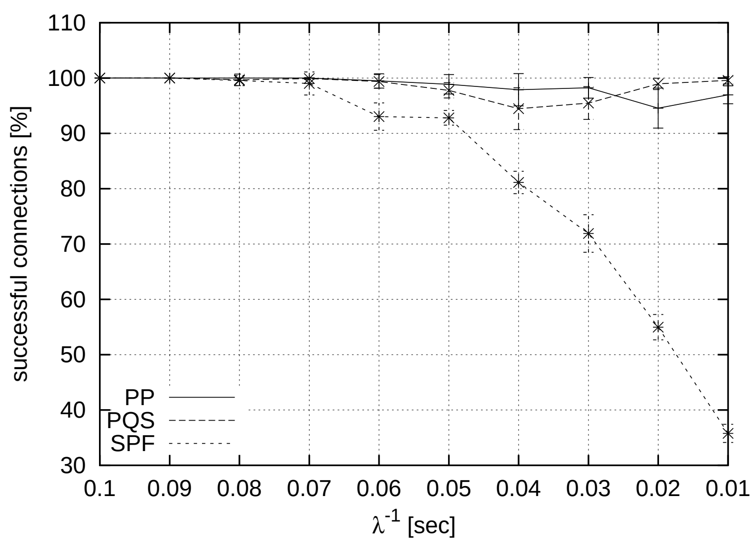

Figure 59: Percentage of successful AF connections for $p_{\mathrm{ER0}} = 0.3$, $p_{\mathrm{EGW}} = 0.5$, and an alternative traffic mix

6.2.4.1 Pruned Candidate Paths in the PP Algorithm

For EF connection requests, paths are generally pruned because of a lack of reserved bandwidth. A few rejections occur because of detected drops. But since the packet drop measurement is rather course (see Section 5.2.1.3), this is a rare event. The delay requirement does not come into play for the pruning process. However, it is the main metric for picking a path eventually.

For AF connection requests, the delay metric is not considered. It turns out, that the bandwidth metric is most of the time the reason for pruning a path. However, since more drops are tolerated in this class, more drops are detected. This leads to more path prunings based on packet drops.

For connection requests in the BE class, only reserved bandwidth is considered. Hence, all paths pruned are pruned due to a lack of reserved bandwidth.

6.2.4.2 Pruned Candidate Paths in the PQS Algorithm

The main reason for pruning paths for EF connection requests is the estimated bottleneck bandwidth on the considered paths. However, both the estimated delay (especially for hotspot loads) and the aggregated number of dropped packets are also frequent reasons.

Pruning of paths for AF connection requests show similar properties. The estimated bottleneck bandwidth is the main reason, but a significant number of drop related path prunings occurred.

Again, the only considered criteria for BE connection requests is bandwidth, so that all prunings occur due to a too small value of the estimated bottleneck bandwidth.

6.3 Quality of Service

6.3.1 EF Delay Distribution

Figure 60, Figure 62, and Figure 64 show cumulative distribution for a connection request inter-arrival time of 5 msec, an ER0 probability of 0.3, and different EGW probabilities for PP, PQS, and SPF, respectively. Both PP and PQS can guarantee high probabilities for low delays while SPF fails as expected in this respect. PP packet delays are approximately

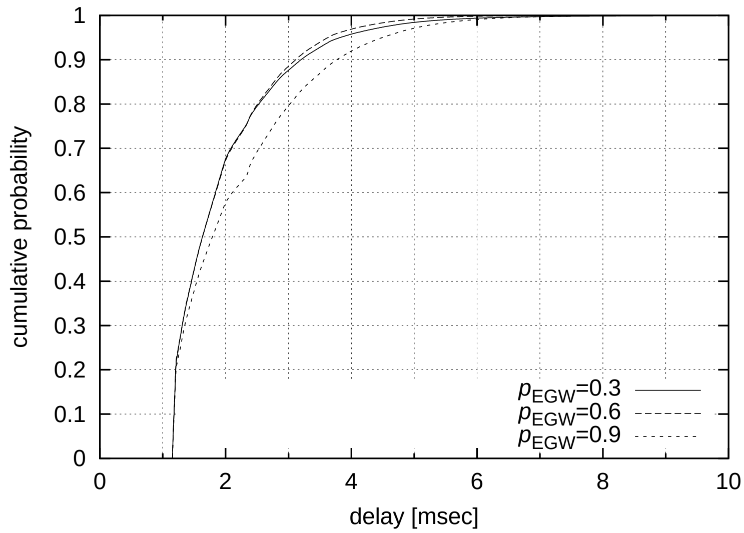

Figure 60: Cumulative distribution functions of EF packet delay for $\lambda^{-1} = 5$ msec and $p_{\mathrm{ER0}} = 0.3$ using the PP algorithm

Table 4: Aggregated time in seconds for EF connections with achieved QoS requirements

p_{EGW}	PP	PQS	SPF
0.3	7881.87	7154.53	2482.72
0.6	8481.18	7958.06	3992.66
0.9	7953.75	8567.70	9144.69

bound by the 26 msec admission criteria as can be seen in Figure 61. The graphs for $p_{\mathrm{EGW}} = 0.6$ and $p_{\mathrm{EGW}} = 0.9$ show even better properties. Figure 63 shows a similar close-up for PQS where the $p_{\mathrm{EGW}} = 0.9$ scenario shows the worst properties. The delay is bound by approximately 18 msec.

To give an idea on the amount of EF packets these CDFs are based on, we show in Table 4 the aggregated time in seconds EF connections have achieved their QoS goals. For PP and PQS, these values are approximately equal so that the curves are easily comparable. For SPF, the aggregated time of successful EF connections is significantly lower for $p_{\mathrm{EGW}} = 0.3$ and $p_{\mathrm{EGW}} = 0.6$. For $p_{\mathrm{EGW}} = 0.9$ and SPF, the amount of time is even bigger than for PP and PQS. However, less than one out of ten connection requests has been successful in this scenario. In contrast, all connections admitted by PP and PQS have been successful.

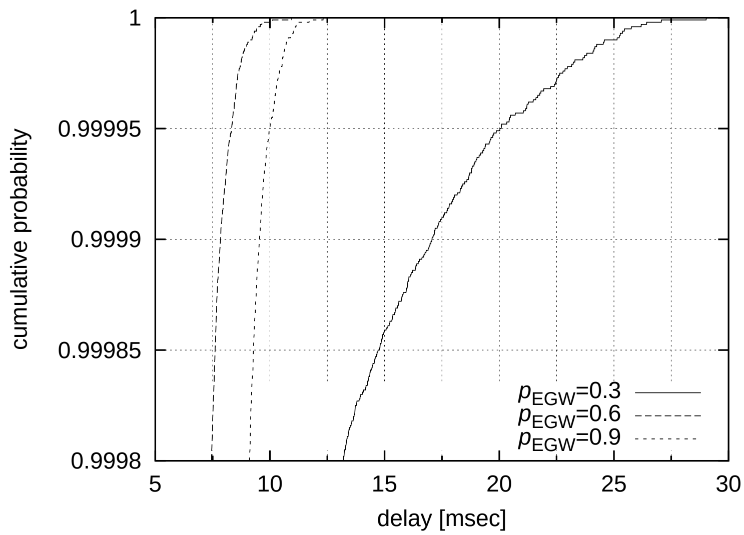

Figure 61: Cumulative distribution functions of EF packet delay for $\lambda^{-1} = 5$ msec and $p_{\mathrm{ER0}} = 0.3$ using the PP algorithm, alternate scale.

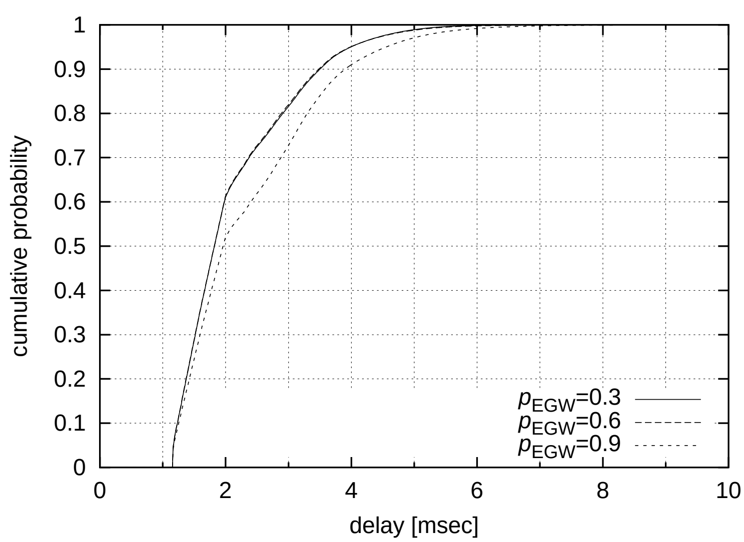

Figure 62: Cumulative distribution functions of EF packet delay for $\lambda^{-1} = 5$ msec and $p_{\mathrm{ER0}} = 0.3$ using the PQS algorithm

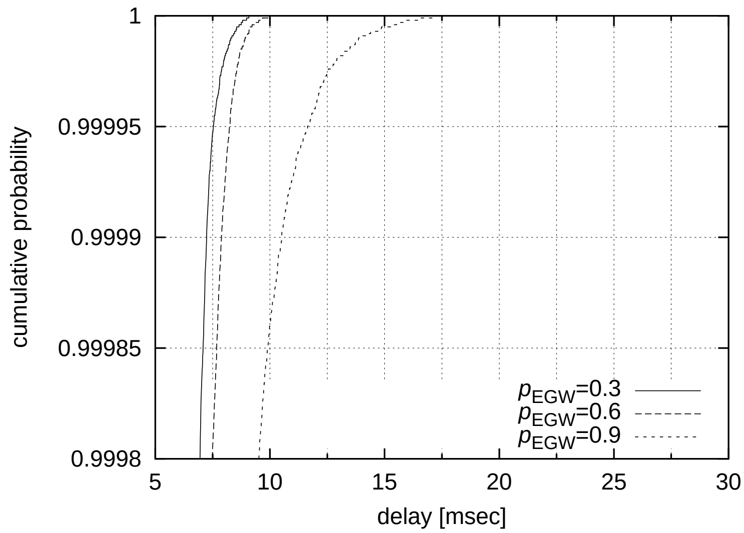

Figure 63: Cumulative distribution functions of EF packet delay for $\lambda^{-1} = 5$ msec and $p_{\mathrm{ER0}} = 0.3$ using the PQS algorithm, alternate scale.

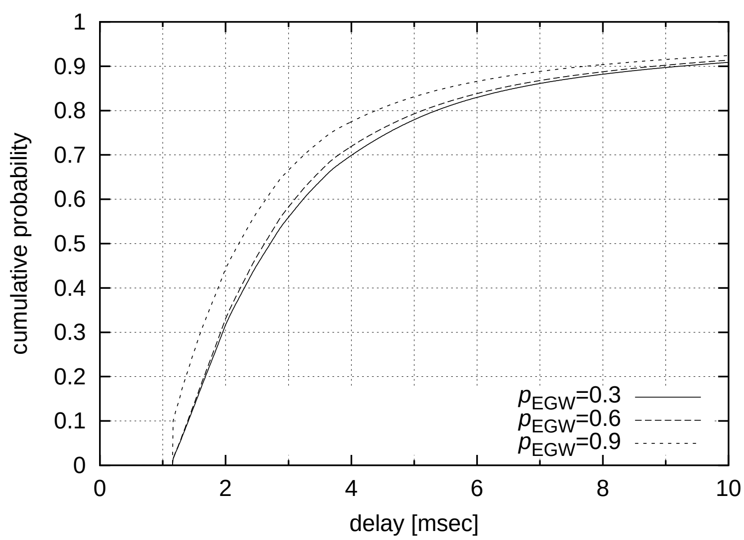

Figure 64: Cumulative distribution functions of EF packet delay for $\lambda^{-1} = 5$ msec and $p_{\mathrm{ER0}} = 0.3$ using the SPF algorithm

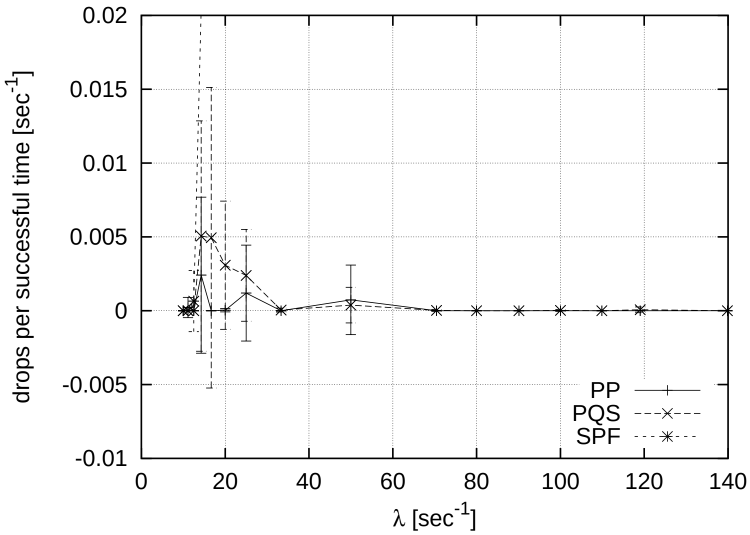

Figure 65: AF packet drops per successful time for $p_{\mathrm{ER0}} = 0.3$ and $p_{\mathrm{EGW}} = 0.5$

6.3.2 AF Packet Loss

As a metric for the AF service quality, we use the number of lost packets per successful connection time. Figure 65 shows plots for this value for $p_{\mathrm{ER0}} = 0.3$, $p_{\mathrm{EGW}} = 0.5$, and a varied connection request arrival rate. The overall performance is best for PP. Both PQS and PP show increased values for low arrival rates. The values for SPF get very high already for low rates.

In Figure 66, we show results for λ^{-1} fixed at 50 msec ($\lambda = 20$ sec^{-1}), $p_{\mathrm{ER0}} = 0.3$, and a varied EGW probability. The PP values are very low, while the sample mean of the PQS values suggest that PQS slightly worse. The SPF values are very high. The same trends can be seen for $p_{\mathrm{ER0}} = 0.9$ (Figure 67). The SPF values are very high and out of the presented scale.

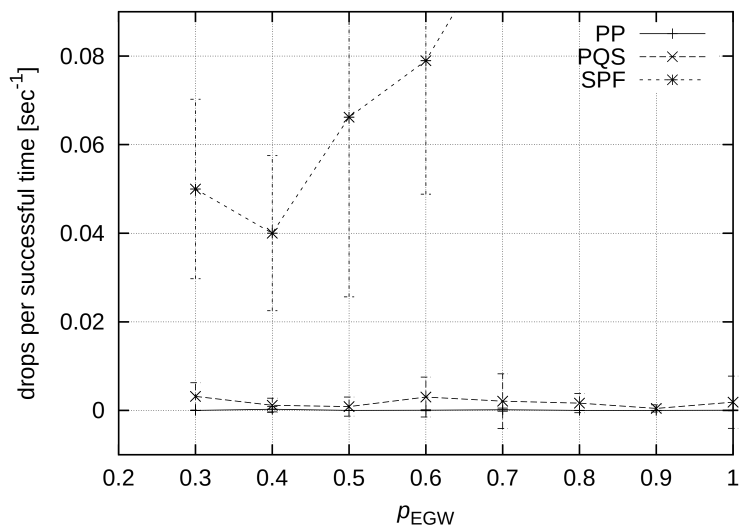

Figure 66: AF packet drops per successful time for $p_{\mathrm{ER0}} = 0.3$ and $\lambda^{-1} = 50$ msec

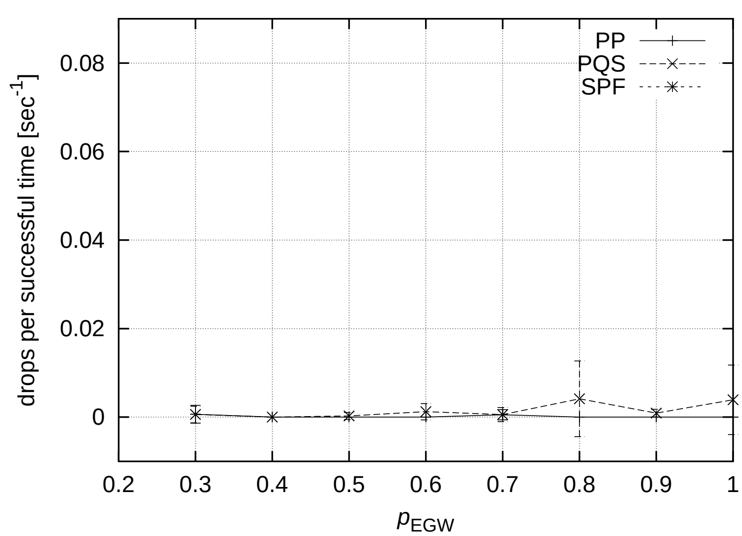

Figure 67: AF packet drops per successful time for $p_{\mathrm{ER0}} = 0.9$ and $\lambda^{-1} = 50$ msec

CHAPTER 7

CONCLUSIONS, CONTRIBUTIONS, AND FUTURE RESEARCH

7.1 Conclusions

We have introduced a framework for measurement-based per-flow traffic engineering and connection admission control. Based on this framework, we have proposed two algorithms, PQS and PP. Both algorithms use state information on different alternative paths between ingress and egress points in the network, but they differ in the way the gather state information. PQS uses information from the queues on each path while PP uses probe packet transmission characteristics as its decision metric.

7.1.1 Framework

Under the assumptions made, both schemes are able to guarantee a certain QoS level for admitted traffic. The proposed algorithms can cope with different traffic distributions throughout the network and different loads as imposed by the rate connection requests arrive at the network.

The strongest assumption is the traffic mix. Knowledge about the expected mix is necessary due to the queuing scheme used. If there is only a small amount of AF and BE traffic, more EF traffic is forwarded. If more AF and BE traffic enters the network, it takes away bandwidth that is used by ongoing EF connections. Hence, such a sudden shift in the traffic mix results in failed connections.

The investigation of the network utilization in Section 6.2.2 showed that the path selection method can be improved. Multiple alternative paths are favorable for reasons of flexibility and resilience, but our evaluation showed that non-shortest paths have to be penalized more strongly. Both algorithms succeed in limiting the maximum load onto the network so that the QoS for admitted traffic is preserved.

The admission parameters for both algorithms are chosen heuristically to both achieve a high number of successful connections while keeping the number of failed connections as close to zero as possible. The comparison to SPF shows that the values determined give both good QoS and utilization results.

7.1.2 Path Queue State-Based Algorithm

For medium arrival rates, PQS turned out to be problematic (Section 6.2.3.3). This is partially due to a shifted actual traffic mix. PQS tends to relatively admit more EF traffic for these arrival rates resulting in the traffic mix problems stated in the previous section. Moreover, since PQS assumes fixed queue service rates, the delay estimate becomes inaccurate (Section 4.3.1).

PQS utilizes the network efficiently and gives good QoS guarantees. Since it only requires some means to query the state of queues on intermediate nodes, it is very scalable with respect to different (and bigger) topologies. An actual implementation has to address some handshaking issues to alter node state information (Section 4.5). These issues are beyond the scope of this research.

7.1.3 Probe Packet-Based Algorithm

The highest guarantee regarding QoS has been achieved by PP. However, PP has also the lowest data packet throughput and the lowest aggregated successful connection time. PP is less scalable than PQS since the RP/DP reservation scheme uses resources on every configured LSP (Section 5.4.7.1). The probes used to measure delay etc. have a negligible impact. The advantage of PP is that it needs nearly no supporting infrastructure in the network core besides the queuing scheme presented in Section 5.4.1.

7.2 Contributions

We created a traffic engineering and call admission control framework for radio access networks or similar, small DiffServ domains. The framework is designed to need little support from the network core and to make most decisions on the edge of the network. These decisions are based on measurements of the network core.

Based on this framework, we developed two algorithms. The first algorithm, PQS, is based on state information of queues in the network core while the second algorithm, PP, gathers data by means of probe packet measurements.

Both algorithms include a connection admission control to assure that all admitted traffic in the network can maintain their QoS level. Moreover, admitted traffic is transmitted over one of multiple possible paths on a per-flow basis.

To evaluate the performance, we implemented both algorithms in ns-2. Additionally, we implemented a number of extensions to ns-2 to easily obtain statistical data and simulate the modeled network efficiently.

We compared PQS and PP to a non-traffic engineering shortest path first routing approach. The results show that our proposed new framework can guarantee admitted connections a certain QoS.

7.3 Future Research

There are multiple directions for further research, which include:

- Evaluate the proposed framework for different and more heterogeneous topologies. Especially with respect to the probe packet-based algorithm, the scalability can be evaluated in more detail.

- Introduce more general traffic classes to the framework and show the effects on the performance. Especially, VBR EF traffic can be investigated. Eventually, an enhanced framework could support traffic classes with continuous parameters rather than four discrete classes.

- Make the algorithms more aware of the hop count of each path to use link resources more efficiently. Moreover, tune the algorithm to perform best for reasonable arrival rates and low blocking probabilities.

- Use more metrics for the PQS scheme including the service rates of each queue. Moreover, a deployable implementation can be designed. This would include the evaluation of all signaling and the design of a handshake and mutual exclusion mechanism for setting queue penalties.

APPENDIX A

EVALUATION OF THE LOCAL STATE FAIR SHARE BANDWIDTH ALGORITHM

A.1 Introduction

In [24], our examination of the local share fair share bandwidth (LSFSB) algorithm shows that it generally performs better than shortest path routing. In most situations it performs equally well or worse than a reference algorithm that incorporates global network state knowledge. For a brief description of the LSFSB algorithm, refer to Section 2.2.4.

A.2 Considered Topology

Figure 68 shows the topology of the RAN that we assume for our evaluations. Mobile devices connect to base stations attached to radio access servers (RASs) on the rim of the network. Those connect to edge routers (ERs) on the edge of the core network. There is one edge gateway (EGW) in the core network that interfaces other RANs and the Internet. To keep this nomenclature general, we also consider the possibility of other routers in the core network that do not inject traffic. These routers are referred to as core routers (CRs).

A.3 Discussion

In [4], Barlow uses a small RAN to evaluate the LSFSB algorithm. Since a RAN is a metropolitan area network, it is valid to assume a relatively small network. In such a RAN it would not be a huge overhead to distribute network state data between the nodes. Thus, the main advantage of the LSFSB algorithm, namely that it does not rely on network state information from other nodes, is not as significant for this topology as it may be for other topologies. However, if the network gets bigger, we expect LSFSB to perform worse since the ratio of the information available to one single router compared to the overall information a globally working algorithm could use gets smaller and smaller. In other words, the portion

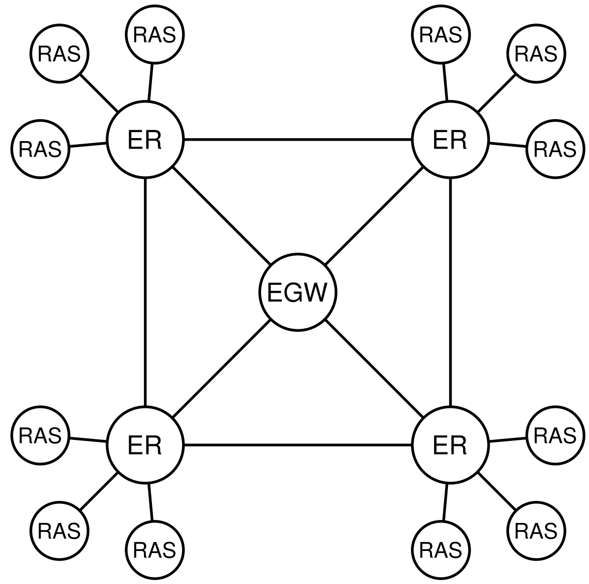

Figure 68: Radio access network topology

of the network state known to a single router that keeps track of its local state decreases with an increasing number of routers in the RAN.

In LSFSB, RASs decide on which LSP traffic is forwarded based on their local state information only. A direct improvement to this algorithm with regard to this fact is to do traffic engineering decisions on the edge routers. These routers can incorporate more information, namely state information of their links into the core. The trade-off here is less scalability.

However, local state information might not be sufficient in every situation. There are some situations where there is a hot spot in the network but a neighboring router does not know about this and starts sending more packets over LSPs that lead through this hot spot.

All this makes LSFSB a good algorithm—in contrast to IP shortest path routing—if one deals with two special scenarios. It can deal well with traffic bursts in a network that is evenly utilized because the bursts can be balanced easily over the network with a low risk to redirect them to a congested area, and it shows a good performance for a network with hot spots and low background traffic. The latter fact assures that there is not a huge amount of additional traffic routed through the hot spot region. However, LSFSB is not the algorithm of choice for traffic engineering to generally avoid hot spots in a network that does not fit to the two constraints given above. Hence, there is a motivation for an improved algorithm.

A.4 Conclusion

Our analysis showed that LSFSB performs well when distributing small load bursts in an evenly utilized network, but it fails if it tries to distribute the load introduced by hot spots in the network when the network itself is already at a high load. Therefore, LSFSB might be applied to the highest level in the network hierarchy in areas with homogeneous traffic demands or in areas with low traffic demands in order to improve the overall service quality.

One should also note that a final evaluation of LSFSB is complicated due to the huge amount of parameters that can vary. The simulator developed by Barlow is very sensitive to changes in the random number generator seed, which results in large confidence intervals for all data gathered. This sensitivity can also be observed when changing the actual simulation parameters.

APPENDIX B

DETAILED RESULTS

In this chapter, we show detailed results for several parameter sets. The parameters are

- p_{EGW}, the probability that the edge gateway is part of a connection,
- p_{ER0}, the probability that edge router 0 is part of a connection,
- λ^{-1}, the call inter-arrival time in seconds, and
- TE, the traffic engineering scheme: 0 for SFP, 1 for PP, 2 for PQS.

For all three traffic engineering schemes, we show results for every combination of p_{EGW} and p_{ER0} varied from 0.3 to 1.0 in steps of 0.1 and λ^{-1} chosen out of 0.005, 0.01, 0.05, and 0.1 seconds. The results presented are averaged over four simulator runs. We show

- packets, the total number of data packets delivered by the network,
- lu, the average link utilization,
- drops, the number of packets dropped,
- ctotal, the total number of connection requests,
- cfail, the number of failed connection due to an insufficient QoS,
- cacc, the number of accepted connections,
- csuc, the number of successful connections, and
- ssuc, the aggregated time of successful connections in seconds.

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.3	0.3	0.005	0	8139050.00	0.98	23951.75	10015.25	9211.00	10015.25	804.25	2497.37	53189.00	9957.50	8089.75	9957.50	1867.75	12083.75	270871.00	9929.75	9929.75
0.3	0.3	0.005	1	6008224.75	0.94	0.00	10015.25	0.00	417.00	417.00	7657.84	0.00	9957.50	0.00	864.75	864.75	16227.38	1884.50	9929.75	1321.25
0.3	0.3	0.005	2	6165522.75	0.95	0.00	10015.25	0.00	401.00	401.00	6968.18	0.00	9957.50	0.00	609.00	609.00	11362.58	70533.75	9929.75	1908.75
0.3	0.3	0.01	0	8037562.75	0.98	10948.25	4985.25	4060.25	4985.25	925.00	5319.65	22867.50	5002.00	3312.25	5002.00	1689.75	15815.59	203053.75	5003.00	5003.00
0.3	0.3	0.01	1	6380221.25	0.97	0.00	4985.25	0.00	505.25	505.25	8932.02	0.00	5002.00	0.00	833.75	833.75	15852.64	1815.75	5003.00	1219.25
0.3	0.3	0.01	2	6129517.25	0.96	0.00	4985.25	0.00	405.25	405.25	7532.18	0.00	5002.00	0.00	594.25	594.25	11175.64	67941.00	5003.00	1784.25
0.3	0.3	0.05	0	6130991.75	0.77	840.25	987.75	213.00	987.75	774.75	12544.67	824.75	1024.25	69.25	1024.25	955.00	16530.55	20838.50	986.00	986.00
0.3	0.3	0.05	1	4891558.25	0.97	0.00	987.75	0.00	549.50	549.50	10179.51	0.00	1024.25	0.00	633.25	633.25	11429.48	256.25	986.00	701.00
0.3	0.3	0.05	2	6089143.25	0.89	117.25	987.75	19.75	711.75	692.00	13261.92	46.75	1024.25	0.50	761.00	760.50	14652.50	4873.25	986.00	917.50
0.3	0.3	0.1	0	3717995.75	0.46	22.25	487.00	6.00	487.00	481.00	8579.03	0.00	499.00	0.00	499.00	499.00	8958.52	96.50	490.75	490.75
0.3	0.3	0.1	1	3487256.75	0.93	0.00	487.00	0.00	441.75	441.75	8060.48	0.00	499.00	0.00	461.75	461.75	8333.85	7.25	490.75	465.75
0.3	0.3	0.1	2	3761109.50	0.48	0.00	487.00	0.00	487.00	487.00	8801.13	0.00	499.00	0.00	499.00	499.00	8958.52	1.75	490.75	490.75
0.3	0.4	0.005	0	8095573.50	0.98	24154.00	10015.75	9235.50	10015.75	780.25	2285.45	53263.75	9986.25	8115.75	9986.25	1870.50	11681.09	273612.50	10002.50	10002.50
0.3	0.4	0.005	1	6178570.75	0.95	0.00	10015.75	0.00	431.50	431.50	7890.77	0.00	9986.25	0.00	885.50	885.50	16574.61	1934.50	10002.50	1394.00
0.3	0.4	0.005	2	6234518.50	0.95	0.00	10015.75	0.00	413.75	413.75	7428.08	0.00	9986.25	0.00	634.50	634.50	11699.61	69938.00	10002.50	1947.00
0.3	0.4	0.01	0	8006862.25	0.98	10961.50	4980.75	4051.75	4980.75	929.00	4992.81	22988.50	5037.25	3323.25	5037.25	1714.00	15546.82	206552.25	4986.25	4986.25
0.3	0.4	0.01	1	6381454.75	0.97	0.00	4980.75	0.00	536.25	536.25	10053.24	1.00	5037.25	0.00	856.75	856.75	16568.25	1998.25	4986.25	1243.50
0.3	0.4	0.01	2	6129162.25	0.96	0.00	4980.75	0.00	412.75	412.75	8417.28	0.00	5037.25	0.00	621.75	621.75	11436.21	70819.50	4986.25	1819.50
0.3	0.4	0.05	0	6360954.00	0.78	733.00	999.75	188.50	999.75	811.25	13444.31	650.25	1009.75	63.50	1009.75	946.25	16398.53	20729.25	994.25	994.25
0.3	0.4	0.05	1	5009768.25	0.97	0.00	999.75	0.00	558.50	558.50	10830.99	0.00	1009.75	0.00	645.00	645.00	11867.66	189.00	994.25	713.25
0.3	0.4	0.05	2	6267440.50	0.89	109.75	999.75	15.75	726.75	711.00	13941.67	38.75	1009.75	1.50	753.75	752.25	14106.74	4824.25	994.25	930.75
0.3	0.4	0.1	0	3785902.50	0.47	0.00	486.50	0.00	486.50	486.50	9123.36	0.00	496.00	0.00	496.00	496.00	9165.99	35.25	497.75	497.75
0.3	0.4	0.1	1	3564795.50	0.94	0.00	486.50	0.00	450.25	450.25	8725.74	0.00	496.00	0.00	463.00	463.00	8540.36	0.50	497.75	479.50
0.3	0.4	0.1	2	3785507.50	0.49	0.00	486.50	0.00	486.50	486.50	9123.36	0.00	496.00	0.00	496.00	496.00	9165.99	1.75	497.75	497.75
0.3	0.5	0.005	0	8044466.75	0.98	23901.00	9950.75	9192.00	9950.75	758.75	2177.61	54012.50	10065.25	8192.00	10065.25	1873.25	11544.54	270341.50	9924.00	9924.00
0.3	0.5	0.005	1	6229931.25	0.96	0.00	9950.75	0.00	436.25	436.25	8519.72	0.00	10065.25	0.00	900.75	900.75	16401.76	2034.25	9924.00	1323.00
0.3	0.5	0.005	2	6269731.25	0.95	0.00	9950.75	0.00	439.00	439.00	8121.59	0.00	10065.25	0.00	637.00	637.00	12060.17	69472.50	9924.00	1926.75
0.3	0.5	0.01	0	7946874.50	0.98	11024.00	5006.75	4124.25	5006.75	882.50	4847.65	22993.00	5007.75	3289.50	5007.75	1718.25	15232.33	203931.50	4964.75	4964.75
0.3	0.5	0.01	1	6399016.75	0.97	0.00	5006.75	0.00	540.25	540.25	9804.65	0.25	5007.75	0.00	851.75	851.75	15541.66	1367.25	4964.75	1202.00
0.3	0.5	0.01	2	5995582.75	0.95	0.00	5006.75	0.00	410.50	410.50	8082.83	0.00	5007.75	0.00	622.25	622.25	11465.99	70977.50	4964.75	1802.50
0.3	0.5	0.05	0	6334183.75	0.78	546.25	981.00	153.50	981.00	827.50	13389.33	635.50	981.25	66.50	981.25	914.75	15866.25	20989.00	1021.50	1021.50
0.3	0.5	0.05	1	4987456.75	0.97	0.00	981.00	0.00	538.50	538.50	10376.88	0.00	981.25	0.00	635.75	635.75	11920.82	253.75	1021.50	719.00
0.3	0.5	0.05	2	6098612.75	0.89	82.75	981.00	17.25	701.75	684.50	12935.22	13.00	981.25	0.00	724.25	724.25	13972.10	6270.25	1021.50	945.00
0.3	0.5	0.1	0	3697864.00	0.46	57.75	502.25	11.50	502.25	490.75	9087.32	0.00	504.50	0.00	504.50	504.50	9206.20	341.50	476.75	476.75
0.3	0.5	0.1	1	3503964.50	0.94	0.00	502.25	0.00	462.25	462.25	8753.33	0.00	504.50	0.00	471.50	471.50	8648.93	15.75	476.75	455.00
0.3	0.5	0.1	2	3748813.75	0.48	0.00	502.25	0.00	502.25	502.25	9348.62	0.00	504.50	0.00	504.50	504.50	9206.20	0.25	476.75	476.75
0.3	0.6	0.005	0	8021627.50	0.98	23882.25	10006.25	9218.00	10006.25	788.25	2441.58	52858.75	9872.50	8040.75	9872.50	1831.75	11825.77	266029.50	10053.75	10053.75
0.3	0.6	0.005	1	6246111.25	0.95	0.00	10006.25	0.00	453.00	453.00	9099.01	0.00	9872.50	0.00	880.75	880.75	16674.48	1510.25	10053.75	1344.00
0.3	0.6	0.005	2	6176593.00	0.95	0.00	10006.25	0.00	423.25	423.25	8431.01	0.00	9872.50	0.00	620.50	620.50	11662.60	67332.50	10053.75	1821.25
0.3	0.6	0.01	0	7916202.25	0.97	11006.25	4955.00	4041.25	4955.00	913.75	5597.64	22965.00	4988.25	3313.75	4988.25	1674.50	15402.97	196735.00	4998.50	4998.50
0.3	0.6	0.01	1	6263298.75	0.97	0.00	4955.00	0.00	551.25	551.25	10529.19	0.00	4988.25	0.00	865.50	865.50	15856.99	1596.50	4998.50	1192.25
0.3	0.6	0.01	2	5941370.00	0.96	0.00	4955.00	0.00	416.25	416.25	8130.08	0.00	4988.25	0.00	585.00	585.00	10650.31	67464.50	4998.50	1746.00
0.3	0.6	0.05	0	5881490.75	0.74	744.25	982.25	231.25	982.25	751.00	12050.85	981.50	1010.00	112.25	1010.00	897.75	14955.16	22323.75	973.50	973.50
0.3	0.6	0.05	1	4712553.25	0.96	0.00	982.25	0.00	519.75	519.75	9394.52	0.00	1010.00	0.00	623.25	623.25	11092.34	317.00	973.50	693.25
0.3	0.6	0.05	2	5757539.50	0.88	89.25	982.25	11.50	647.50	636.00	11613.40	7.25	1010.00	0.00	708.25	708.25	13493.64	6968.75	973.50	882.75
0.3	0.6	0.1	0	3523084.50	0.45	117.00	488.75	30.00	488.75	458.75	8162.83	39.50	509.50	2.75	509.50	506.75	8931.03	3904.50	501.00	501.00
0.3	0.6	0.1	1	3396206.00	0.93	0.00	488.75	0.00	440.25	440.25	8252.58	0.00	509.50	0.00	465.00	465.00	8341.45	0.50	501.00	476.00
0.3	0.6	0.1	2	3640075.25	0.48	0.00	488.75	0.00	488.75	488.75	9023.40	0.00	509.50	0.00	509.50	509.50	9044.19	2.25	501.00	501.00

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.3	0.7	0.005	0	7981873.50	0.98	24034.25	9978.00	9184.50	9978.00	793.50	2869.19	53456.00	9989.25	8089.25	9989.25	1900.00	13160.89	253257.50	9880.00	9880.00
0.3	0.7	0.005	1	6267196.00	0.96	0.00	9978.00	0.00	444.50	444.50	8970.19	0.00	9989.25	0.00	863.00	863.00	15384.68	1946.00	9880.00	1270.75
0.3	0.7	0.005	2	6095387.75	0.95	0.00	9978.00	0.00	424.25	424.25	8185.58	0.00	9989.25	0.00	614.50	614.50	11128.95	60877.50	9880.00	1811.75
0.3	0.7	0.01	0	7857839.75	0.97	10819.25	4967.75	4045.25	4967.75	922.50	6206.23	22811.00	5001.00	3319.25	5001.00	1681.75	16589.77	180604.00	5015.00	5015.00
0.3	0.7	0.01	1	6068907.00	0.97	0.00	4967.75	0.00	505.25	505.25	9785.71	6.25	5001.00	0.25	830.75	830.50	15351.90	1262.25	5015.00	1107.25
0.3	0.7	0.01	2	5860271.25	0.95	0.00	4967.75	0.00	408.50	408.50	7727.62	0.00	5001.00	0.00	588.50	588.50	11278.57	59267.75	5015.00	1684.75
0.3	0.7	0.05	0	5603569.50	0.69	1024.00	1028.00	313.50	1028.00	714.50	11324.56	1306.75	978.50	162.50	978.50	816.00	13170.78	24930.75	1010.50	1010.50
0.3	0.7	0.05	1	4666097.00	0.96	25.25	1028.00	5.50	518.00	512.50	9529.28	0.00	978.50	0.00	561.50	561.50	10590.78	266.75	1010.50	673.50
0.3	0.7	0.05	2	5516236.25	0.85	186.00	1028.00	30.00	665.00	635.00	12289.29	23.50	978.50	0.00	646.00	646.00	12210.82	7843.50	1010.50	884.00
0.3	0.7	0.1	0	3400114.25	0.43	208.75	497.25	50.50	497.25	446.75	7942.60	160.75	493.50	11.25	493.50	482.25	8853.76	5077.75	489.50	489.50
0.3	0.7	0.1	1	3288863.00	0.91	0.00	497.25	0.00	429.50	429.50	8017.39	0.00	493.50	0.00	439.00	439.00	8234.62	9.25	489.50	454.00
0.3	0.7	0.1	2	3706257.50	0.49	0.00	497.25	0.00	497.25	497.25	9356.13	58.75	493.50	3.50	493.25	489.75	9076.34	63.50	489.50	489.50
0.3	0.8	0.005	0	7934172.25	0.98	24058.50	9969.00	9211.00	9969.00	758.00	4069.37	53513.25	9977.75	8090.75	9977.75	1887.00	14731.72	229804.25	9982.25	9982.25
0.3	0.8	0.005	1	6137673.00	0.97	0.00	9969.00	0.00	473.50	473.50	9121.27	3.00	9977.75	0.00	843.75	843.75	15596.04	1701.50	9982.25	1173.00
0.3	0.8	0.005	2	5989320.25	0.95	0.00	9969.00	0.00	415.50	415.50	8029.20	0.00	9977.75	0.00	588.25	588.25	10317.00	53505.50	9982.25	1674.00
0.3	0.8	0.01	0	7735800.50	0.96	11049.50	5067.00	4135.25	5067.00	931.75	7687.06	23389.25	4998.50	3474.25	4998.50	1524.25	15889.11	154506.25	5003.50	5003.50
0.3	0.8	0.01	1	5699353.25	0.97	0.00	5067.00	0.00	477.75	477.75	8658.62	0.00	4998.50	0.00	747.00	747.00	14272.70	1229.50	5003.50	1030.50
0.3	0.8	0.01	2	5762807.50	0.95	0.00	5067.00	0.00	426.75	426.75	8456.96	0.00	4998.50	0.00	573.75	573.75	10480.42	53989.75	5003.50	1582.50
0.3	0.8	0.05	0	4821819.50	0.59	1163.00	972.50	371.75	972.50	600.75	8324.11	2042.75	1006.75	245.50	1006.75	761.25	12308.13	36123.75	992.75	992.75
0.3	0.8	0.05	1	4083143.25	0.92	0.00	972.50	0.00	437.25	437.25	7845.99	0.00	1006.75	0.00	527.00	527.00	10120.62	329.25	992.75	602.75
0.3	0.8	0.05	2	4833847.00	0.80	22.00	972.50	2.75	520.00	517.25	9112.76	0.50	1006.75	0.00	574.00	574.00	11341.91	14036.75	992.75	816.50
0.3	0.8	0.1	0	3255138.75	0.41	244.50	496.50	67.50	496.50	429.00	7105.39	388.50	521.25	36.25	521.25	485.00	8452.78	7907.00	492.25	492.25
0.3	0.8	0.1	1	3169401.75	0.89	0.00	496.50	0.00	385.50	385.50	7154.08	5.50	521.25	0.25	426.50	426.25	8043.89	100.50	492.25	430.75
0.3	0.8	0.1	2	3671759.00	0.51	115.75	496.50	33.25	477.00	443.75	8282.91	166.00	521.25	8.00	509.00	501.00	9228.36	585.75	492.25	489.00
0.3	0.9	0.005	0	7748525.00	0.97	23946.25	10022.00	9241.50	10022.00	780.50	6866.14	53889.00	10011.50	8182.25	10011.50	1829.25	17590.86	186774.50	9992.50	9992.50
0.3	0.9	0.005	1	5442946.50	0.96	0.00	10022.00	0.00	449.75	449.75	8384.89	0.00	10011.50	0.00	707.75	707.75	13434.25	1138.50	9992.50	1018.75
0.3	0.9	0.005	2	5612051.25	0.94	0.00	10022.00	0.00	420.75	420.75	7544.78	0.00	10011.50	0.00	565.75	565.75	10457.80	44708.75	9992.50	1512.75
0.3	0.9	0.01	0	6911879.50	0.86	11158.50	5080.25	4301.00	5080.25	779.25	9343.97	24417.00	4973.25	3705.50	4973.25	1267.75	13229.81	119588.00	4953.50	4953.50
0.3	0.9	0.01	1	4998716.50	0.96	0.00	5080.25	0.00	469.50	469.50	9245.15	0.00	4973.25	0.00	689.75	689.75	13084.96	551.00	4953.50	925.25
0.3	0.9	0.01	2	5371147.75	0.93	0.00	5080.25	0.00	448.75	448.75	8999.46	0.00	4973.25	0.00	549.75	549.75	10089.01	38437.00	4953.50	1353.75
0.3	0.9	0.05	0	4055312.25	0.51	1415.25	984.75	453.25	984.75	531.50	6558.70	2444.00	1005.00	307.25	1005.00	697.75	10665.36	44077.25	1017.75	1017.75
0.3	0.9	0.05	1	3509140.00	0.87	0.00	984.75	0.00	346.00	346.00	6634.62	5.25	1005.00	0.00	430.25	430.25	8260.62	520.25	1017.75	544.50
0.3	0.9	0.05	2	3991880.25	0.72	29.25	984.75	7.25	413.50	406.25	7354.14	5.50	1005.00	0.00	483.25	483.25	9266.49	17842.25	1017.75	753.75
0.3	0.9	0.1	0	3070363.75	0.38	298.00	499.50	92.00	499.50	407.50	6575.73	429.25	475.00	39.00	475.00	436.00	7641.19	14070.00	514.75	514.75
0.3	0.9	0.1	1	2918642.25	0.85	0.00	499.50	0.00	353.50	353.50	6894.10	0.00	475.00	0.00	364.25	364.25	6927.40	37.75	514.75	421.25
0.3	0.9	0.1	2	3467267.00	0.52	180.75	499.50	43.50	463.75	420.25	7611.23	42.50	475.00	1.50	443.75	442.25	8290.42	1311.50	514.75	510.25
0.3	1.0	0.005	0	3414616.75	0.43	25030.75	10041.75	9806.50	10041.75	235.25	294.83	58035.25	10022.75	8901.00	10022.75	1121.75	6619.98	143137.00	9946.75	9946.75
0.3	1.0	0.005	1	2225692.25	0.73	0.00	10041.75	0.00	95.75	95.75	2078.20	0.00	10022.75	0.00	346.25	346.25	6266.67	677.25	9946.75	581.00
0.3	1.0	0.005	2	3096176.25	0.64	0.00	10041.75	0.00	224.75	224.75	4092.63	0.25	10022.75	0.00	327.00	327.00	6204.90	29406.75	9946.75	798.25
0.3	1.0	0.01	0	3390185.25	0.43	11852.00	4939.75	4607.25	4939.75	332.50	815.32	27182.50	4952.75	4132.75	4952.75	820.00	4894.90	119403.00	4988.75	4988.75
0.3	1.0	0.01	1	2297182.75	0.74	0.00	4939.75	0.00	121.50	121.50	2419.86	0.00	4952.75	0.00	343.25	343.25	6536.10	565.50	4988.75	571.75
0.3	1.0	0.01	2	3064982.75	0.66	0.00	4939.75	0.00	232.25	232.25	4595.49	0.00	4952.75	0.00	327.00	327.00	6055.67	33656.75	4988.75	878.75
0.3	1.0	0.05	0	3352201.25	0.42	1780.25	998.50	580.00	998.50	418.50	4608.74	3419.00	1027.25	432.50	1027.25	594.75	7932.47	52118.25	1005.50	1005.50
0.3	1.0	0.05	1	2752023.00	0.81	0.00	998.50	0.00	248.75	248.75	4545.64	0.00	1027.25	0.00	353.25	353.25	6745.52	467.00	1005.50	458.50
0.3	1.0	0.05	2	3277536.00	0.63	15.75	998.50	1.50	307.50	306.00	5770.42	0.25	1027.25	0.00	369.25	369.25	6888.53	21178.50	1005.50	674.00
0.3	1.0	0.1	0	2846060.25	0.35	380.00	486.50	135.75	486.50	350.75	5657.98	659.00	497.25	68.50	497.25	428.75	6872.27	16387.50	502.50	502.50
0.3	1.0	0.1	1	2647194.00	0.82	0.00	486.50	0.00	281.00	281.00	5722.71	0.00	497.25	0.00	338.50	338.50	6080.52	100.00	502.50	386.00
0.3	1.0	0.1	2	3245192.25	0.52	158.25	486.50	27.50	392.50	365.00	6947.44	49.25	497.25	0.75	411.25	410.50	7716.12	3172.25	502.50	483.75

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.4	0.3	0.005	0	8320462.50	0.98	23838.00	9931.50	9102.75	9931.50	828.75	2779.23	52304.00	9931.25	7998.00	9931.25	1933.25	12714.03	275120.25	10041.00	10041.00
0.4	0.3	0.005	1	6226801.25	0.95	0.00	9931.50	0.00	407.00	407.00	8064.63	0.00	9931.25	0.00	883.00	883.00	16394.03	1840.00	10041.00	1394.00
0.4	0.3	0.005	2	6280791.75	0.95	0.00	9931.50	0.00	422.75	422.75	7616.85	0.00	9931.25	0.00	646.75	646.75	11724.79	72147.75	10041.00	1991.25
0.4	0.3	0.01	0	8268638.50	0.98	11035.00	5020.75	4059.00	5020.75	961.75	6162.91	22965.75	5024.25	3309.25	5024.25	1715.00	15925.90	201761.75	4942.75	4942.75
0.4	0.3	0.01	1	6456985.50	0.97	0.00	5020.75	0.00	548.50	548.50	9935.93	0.00	5024.25	0.00	899.50	899.50	16813.25	1484.50	4942.75	1213.75
0.4	0.3	0.01	2	6149843.50	0.96	0.00	5020.75	0.00	421.00	421.00	7582.35	0.00	5024.25	0.00	625.00	625.00	11578.00	68649.25	4942.75	1795.50
0.4	0.3	0.05	0	6260777.75	0.75	882.25	1038.50	248.00	1038.50	790.50	12640.05	646.25	974.75	56.25	974.75	918.50	16349.66	18110.75	987.00	987.00
0.4	0.3	0.05	1	5131677.75	0.97	8.75	1038.50	0.00	578.25	578.25	11247.01	3.50	974.75	0.00	638.25	638.25	12331.75	264.50	987.00	707.25
0.4	0.3	0.05	2	6333786.50	0.88	246.00	1038.50	58.75	771.25	712.50	13651.81	17.75	974.75	0.00	770.75	770.75	15448.37	4287.00	987.00	936.75
0.4	0.3	0.1	0	3720830.25	0.45	0.00	495.50	0.00	495.50	495.50	8969.31	0.00	513.50	0.00	513.50	513.50	9008.33	144.75	516.00	516.00
0.4	0.3	0.1	1	3493610.50	0.94	0.00	495.50	0.00	462.00	462.00	8288.49	0.00	513.50	0.00	481.25	481.25	8572.28	5.75	516.00	493.50
0.4	0.3	0.1	2	3720760.75	0.47	0.00	495.50	0.00	495.50	495.50	8969.31	0.00	513.50	0.00	513.50	513.50	9008.33	0.00	516.00	516.00
0.4	0.4	0.005	0	8288035.50	0.98	23841.75	10047.00	9216.00	10047.00	831.00	2469.08	53615.75	10025.25	8109.50	10025.25	1915.75	12110.78	276646.00	9931.00	9931.00
0.4	0.4	0.005	1	6212985.25	0.95	0.00	10047.00	0.00	405.50	405.50	8114.48	0.00	10025.25	0.00	885.75	885.75	16690.95	1686.25	9931.00	1327.25
0.4	0.4	0.005	2	6315971.50	0.95	0.00	10047.00	0.00	428.50	428.50	8177.61	0.00	10025.25	0.00	634.75	634.75	11495.18	69113.50	9931.00	1942.00
0.4	0.4	0.01	0	8230835.25	0.98	10877.25	4995.50	3989.00	4995.50	1006.50	5844.68	22680.00	5036.50	3261.00	5036.50	1775.50	16581.69	206132.50	5023.50	5023.50
0.4	0.4	0.01	1	6376786.25	0.97	0.00	4995.50	0.00	527.00	527.00	9866.27	0.00	5036.50	0.00	832.75	832.75	15272.26	1893.00	5023.50	1238.75
0.4	0.4	0.01	2	6161885.00	0.96	0.00	4995.50	0.00	431.50	431.50	7825.06	0.00	5036.50	0.00	619.25	619.25	11201.70	72997.75	5023.50	1847.75
0.4	0.4	0.05	0	6373791.25	0.76	726.75	991.75	177.00	991.75	814.75	13183.84	823.50	1016.00	71.75	1016.00	944.25	16424.28	23474.75	1001.75	1001.75
0.4	0.4	0.05	1	5077540.25	0.97	21.75	991.75	5.75	555.75	550.00	10555.25	0.25	1016.00	0.00	643.25	643.25	12190.76	287.75	1001.75	721.75
0.4	0.4	0.05	2	6224428.50	0.88	172.50	991.75	46.00	735.75	689.75	13206.02	14.75	1016.00	0.00	777.25	777.25	15313.87	4620.00	1001.75	943.25
0.4	0.4	0.1	0	3823159.50	0.46	18.75	517.25	3.75	517.25	513.50	9554.83	2.50	503.00	0.00	503.00	503.00	9443.07	181.75	486.75	486.75
0.4	0.4	0.1	1	3614991.00	0.94	0.00	517.25	0.00	478.50	478.50	9014.02	0.00	503.00	0.00	475.00	475.00	9097.24	7.75	486.75	468.25
0.4	0.4	0.1	2	3833040.50	0.48	0.00	517.25	0.00	517.25	517.25	9630.09	0.00	503.00	0.00	503.00	503.00	9443.07	2.00	486.75	486.75
0.4	0.5	0.005	0	8273198.75	0.98	24206.75	10009.75	9227.00	10009.75	782.75	2460.34	53141.50	10019.00	8075.50	10019.00	1943.50	12375.40	271937.25	9933.25	9933.25
0.4	0.5	0.005	1	6227730.75	0.95	0.00	10009.75	0.00	422.50	422.50	8196.60	0.00	10019.00	0.00	888.25	888.25	16605.68	1737.00	9933.25	1364.00
0.4	0.5	0.005	2	6212362.25	0.95	0.00	10009.75	0.00	430.75	430.75	7794.15	0.00	10019.00	0.00	621.50	621.50	11659.41	67882.00	9933.25	1903.50
0.4	0.5	0.01	0	8218120.00	0.98	11141.50	5050.50	4089.00	5050.50	961.50	5583.68	22828.75	5042.00	3287.00	5042.00	1755.00	16539.90	207658.25	5016.75	5016.75
0.4	0.5	0.01	1	6470946.50	0.96	0.00	5050.50	0.00	509.25	509.25	9992.23	0.00	5042.00	0.00	864.50	864.50	16176.60	1869.75	5016.75	1216.25
0.4	0.5	0.01	2	6087542.00	0.96	0.00	5050.50	0.00	404.75	404.75	7642.36	0.00	5042.00	0.00	589.00	589.00	11224.21	73675.00	5016.75	1777.50
0.4	0.5	0.05	0	6119299.00	0.74	597.75	969.75	182.00	969.75	787.75	12855.62	928.25	1017.00	99.25	1017.00	917.75	15411.51	20563.00	1010.25	1010.25
0.4	0.5	0.05	1	4910277.50	0.97	0.00	969.75	0.00	530.75	530.75	10211.11	3.00	1017.00	0.00	647.00	647.00	12126.12	283.75	1010.25	717.00
0.4	0.5	0.05	2	6092602.00	0.88	106.50	969.75	26.50	712.50	686.00	13382.94	78.00	1017.00	0.25	768.00	767.75	14890.25	5188.25	1010.25	943.75
0.4	0.5	0.1	0	3697098.00	0.45	85.25	502.50	26.75	502.50	475.75	8603.88	43.50	484.50	1.50	484.50	483.00	9001.81	3008.75	496.25	496.25
0.4	0.5	0.1	1	3558869.00	0.93	0.00	502.50	0.00	461.50	461.50	8563.76	0.00	484.50	0.00	451.75	451.75	8452.24	22.00	496.25	473.75
0.4	0.5	0.1	2	3794657.00	0.48	0.00	502.50	0.00	502.50	502.50	9220.53	0.00	484.50	0.00	484.50	484.50	9049.93	11.00	496.25	496.25
0.4	0.6	0.005	0	8257547.25	0.98	23876.75	9917.50	9072.75	9917.50	844.75	2844.11	53729.75	10078.75	8103.00	10078.75	1975.75	13306.70	265558.75	9960.75	9960.75
0.4	0.6	0.005	1	6355026.00	0.96	0.00	9917.50	0.00	451.25	451.25	8776.42	0.00	10078.75	0.00	911.50	911.50	16619.12	1638.50	9960.75	1363.50
0.4	0.6	0.005	2	6172590.25	0.95	0.00	9917.50	0.00	424.00	424.00	8219.81	0.00	10078.75	0.00	629.00	629.00	11394.54	66030.50	9960.75	1863.75
0.4	0.6	0.01	0	8151980.50	0.98	11026.00	4963.50	4030.50	4963.50	933.00	5936.35	22136.25	4913.75	3177.00	4913.75	1736.75	16710.95	197852.00	4961.25	4961.25
0.4	0.6	0.01	1	6298452.50	0.97	0.00	4963.50	0.00	512.75	512.75	10290.57	6.25	4913.75	0.25	855.50	855.25	15467.15	1883.50	4961.25	1204.75
0.4	0.6	0.01	2	6073165.50	0.95	0.00	4963.50	0.00	426.25	426.25	7997.52	0.00	4913.75	0.00	600.50	600.50	11439.65	63615.75	4961.25	1790.00
0.4	0.6	0.05	0	5843580.75	0.70	766.50	990.75	247.00	990.75	743.75	13122.75	1097.50	989.25	134.00	989.25	855.25	14394.59	21229.25	976.75	976.75
0.4	0.6	0.05	1	4855530.00	0.97	0.00	990.75	0.00	543.75	543.75	10958.47	14.25	989.25	0.25	618.50	618.25	11694.05	223.75	976.75	675.25
0.4	0.6	0.05	2	5820323.25	0.88	155.25	990.75	32.75	683.25	650.50	12958.87	33.50	989.25	0.00	715.25	715.25	13733.03	5962.00	976.75	894.50
0.4	0.6	0.1	0	3390019.75	0.42	162.25	487.00	44.00	487.00	443.00	7401.43	106.25	508.75	7.75	508.75	501.00	9460.58	4788.50	499.00	499.00
0.4	0.6	0.1	1	3330913.00	0.92	0.00	487.00	0.00	438.75	438.75	7436.67	4.00	508.75	0.25	470.75	470.50	9037.08	6.00	499.00	470.50
0.4	0.6	0.1	2	3610416.25	0.47	0.00	487.00	0.00	487.00	487.00	8343.32	47.50	508.75	3.25	508.75	505.50	9592.18	9.25	499.00	499.00

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.4	0.7	0.005	0	8202533.75	0.98	24003.25	10056.25	9249.00	10056.25	807.25	3422.12	53386.25	10041.00	8080.50	10041.00	1960.50	14109.06	255225.00	10000.50	10000.50
0.4	0.7	0.005	1	6195078.50	0.95	0.00	10056.25	0.00	418.75	418.75	8729.99	0.00	10041.00	0.00	860.00	860.00	16225.52	2389.75	10000.50	1277.25
0.4	0.7	0.005	2	6106102.25	0.95	0.00	10056.25	0.00	426.00	426.00	8267.96	2.50	10041.00	0.25	611.75	611.50	11113.23	65062.00	10000.50	1853.75
0.4	0.7	0.01	0	8144596.50	0.97	10973.75	5015.75	4058.75	5015.75	957.00	6751.28	22685.00	4958.00	3286.00	4958.00	1672.00	17156.22	182468.50	5010.75	5010.75
0.4	0.7	0.01	1	6174625.00	0.97	0.00	5015.75	0.00	506.75	506.75	9821.50	0.00	4958.00	0.00	828.50	828.50	15372.77	1472.00	5010.75	1160.25
0.4	0.7	0.01	2	5982866.50	0.95	0.00	5015.75	0.00	427.00	427.00	8168.96	0.00	4958.00	0.00	601.25	601.25	11565.63	59038.50	5010.75	1688.75
0.4	0.7	0.05	0	5302517.25	0.63	977.75	1008.50	333.25	1008.50	675.25	10340.02	1597.75	1010.25	191.25	1010.25	819.00	13068.56	25560.75	968.75	968.75
0.4	0.7	0.05	1	4527701.25	0.95	0.00	1008.50	0.00	496.75	496.75	9039.49	0.00	1010.25	0.00	586.00	586.00	10667.07	346.00	968.75	647.75
0.4	0.7	0.05	2	5429724.75	0.85	162.75	1008.50	7.25	631.25	624.00	11873.47	11.50	1010.25	0.25	671.00	670.75	12748.10	9450.25	968.75	848.50
0.4	0.7	0.1	0	3357898.50	0.41	274.00	493.75	69.25	493.75	424.50	6810.33	342.50	529.50	35.25	529.50	494.25	8751.05	11414.25	492.50	492.50
0.4	0.7	0.1	1	3434970.00	0.91	0.00	493.75	0.00	412.25	412.25	7223.61	27.75	529.50	2.25	457.75	455.50	8882.16	3.50	492.50	445.25
0.4	0.7	0.1	2	3860307.25	0.51	32.25	493.75	11.00	493.75	482.75	8205.16	77.25	529.50	5.50	529.00	523.50	9907.45	72.25	492.50	492.50
0.4	0.8	0.005	0	8181699.25	0.98	24252.75	9970.75	9121.25	9970.75	849.50	4908.36	52918.75	9919.00	7931.25	9919.00	1987.75	16600.68	234098.00	9941.75	9941.75
0.4	0.8	0.005	1	6045395.50	0.96	0.00	9970.75	0.00	482.50	482.50	9379.21	0.00	9919.00	0.00	838.00	838.00	14957.03	2274.25	9941.75	1239.25
0.4	0.8	0.005	2	5956701.25	0.94	0.00	9970.75	0.00	426.00	426.00	7559.10	0.00	9919.00	0.00	616.50	616.50	11120.07	57103.75	9941.75	1741.00
0.4	0.8	0.01	0	7925768.75	0.96	10785.75	5009.75	4093.00	5009.75	916.75	8632.66	23659.25	5075.00	3492.75	5075.00	1582.25	17327.26	150716.75	5069.00	5069.00
0.4	0.8	0.01	1	5881813.75	0.97	0.00	5009.75	0.00	517.00	517.00	9831.64	0.00	5075.00	0.00	798.00	798.00	14845.32	1444.50	5069.00	1061.25
0.4	0.8	0.01	2	5750441.25	0.95	0.00	5009.75	0.00	410.25	410.25	7979.55	0.00	5075.00	0.00	599.00	599.00	10862.77	53999.75	5069.00	1595.00
0.4	0.8	0.05	0	4648269.00	0.56	1306.00	1009.00	445.75	1009.00	563.25	8021.84	2128.00	1014.00	268.25	1014.00	745.75	11908.69	30571.25	999.25	999.25
0.4	0.8	0.05	1	4135753.50	0.93	0.00	1009.00	0.00	434.50	434.50	8505.08	0.00	1014.00	0.00	528.75	528.75	9965.48	468.00	999.25	579.00
0.4	0.8	0.05	2	4820026.50	0.79	58.00	1009.00	14.75	521.50	506.75	9580.84	11.75	1014.00	0.00	572.25	572.25	10921.58	15179.50	999.25	800.00
0.4	0.8	0.1	0	3158760.50	0.38	330.00	505.75	93.75	505.75	412.00	7030.35	469.50	502.00	38.75	502.00	463.25	7705.24	10876.25	506.50	506.50
0.4	0.8	0.1	1	3106435.50	0.88	0.00	505.75	0.00	381.50	381.50	7259.40	3.50	502.00	0.00	408.25	408.25	7061.88	28.25	506.50	425.25
0.4	0.8	0.1	2	3721398.25	0.51	18.25	505.75	6.50	490.50	484.00	9026.59	132.50	502.00	3.25	482.25	479.00	8389.00	590.25	506.50	504.75
0.4	0.9	0.005	0	7913226.25	0.96	24359.50	10068.50	9274.25	10068.50	794.25	6808.99	53331.25	10006.00	8123.75	10006.00	1882.25	18959.99	179616.25	9983.00	9983.00
0.4	0.9	0.005	1	5677381.50	0.97	18.50	10068.50	5.00	463.00	458.00	8985.99	0.00	10006.00	0.00	711.25	711.25	12866.47	1348.50	9983.00	1008.25
0.4	0.9	0.005	2	5778219.75	0.94	0.00	10068.50	0.00	428.50	428.50	8126.62	0.00	10006.00	0.00	560.00	560.00	9963.26	42619.75	9983.00	1520.50
0.4	0.9	0.01	0	6928034.25	0.84	10898.75	4961.25	4181.50	4961.25	779.75	8568.80	24254.00	4954.00	3641.50	4954.00	1312.50	14423.22	118951.00	5039.50	5039.50
0.4	0.9	0.01	1	5023300.25	0.96	0.00	4961.25	0.00	454.25	454.25	8813.05	0.00	4954.00	0.00	678.00	678.00	12516.90	602.50	5039.50	880.50
0.4	0.9	0.01	2	5530107.50	0.93	0.00	4961.25	0.00	446.00	446.00	8327.01	0.00	4954.00	0.00	572.75	572.75	10679.03	39169.75	5039.50	1393.00
0.4	0.9	0.05	0	4078384.75	0.49	1451.75	1005.75	485.50	1005.75	520.25	6746.81	2263.25	993.75	308.75	993.75	685.00	10413.60	36906.25	1000.25	1000.25
0.4	0.9	0.05	1	3493441.50	0.86	0.00	1005.75	0.00	365.50	365.50	6911.30	0.00	993.75	0.00	452.00	452.00	8624.07	282.50	1000.25	538.75
0.4	0.9	0.05	2	4144400.75	0.71	0.00	1005.75	0.00	424.75	424.75	8144.73	0.00	993.75	0.00	458.00	458.00	9008.52	17698.00	1000.25	734.50
0.4	0.9	0.1	0	2878411.00	0.35	394.50	490.00	117.50	490.00	372.50	5814.48	692.75	522.75	77.75	522.75	445.00	7303.91	16398.75	531.50	531.50
0.4	0.9	0.1	1	2829597.50	0.84	0.00	490.00	0.00	330.50	330.50	6389.03	12.50	522.75	0.25	381.50	381.25	6938.03	54.00	531.50	422.00
0.4	0.9	0.1	2	3413074.25	0.51	111.50	490.00	32.25	449.25	417.00	7626.38	89.00	522.75	4.75	474.75	470.00	8509.96	1557.75	531.50	522.00
0.4	1.0	0.005	0	3409028.50	0.42	25249.50	9988.50	9748.50	9988.50	240.00	331.98	57589.75	10016.25	8837.50	10016.25	1178.75	7248.86	142567.50	10057.75	10057.75
0.4	1.0	0.005	1	2310399.00	0.73	0.00	9988.50	0.00	112.75	112.75	2219.82	0.00	10016.25	0.00	325.75	325.75	6318.67	718.75	10057.75	561.25
0.4	1.0	0.005	2	3088800.25	0.64	11.25	9988.50	0.00	227.50	227.50	4664.98	5.00	10016.25	0.00	321.00	321.00	5958.12	28232.75	10057.75	827.00
0.4	1.0	0.01	0	3362626.50	0.41	12022.50	5010.75	4706.75	5010.75	304.00	904.71	27473.25	4999.50	4150.00	4999.50	849.50	5389.37	117809.75	5050.25	5050.25
0.4	1.0	0.01	1	2376846.50	0.73	0.00	5010.75	0.00	149.75	149.75	2737.13	0.00	4999.50	0.00	341.50	341.50	6358.61	758.75	5050.25	517.75
0.4	1.0	0.01	2	3080391.00	0.64	0.00	5010.75	0.00	225.00	225.00	4352.79	0.00	4999.50	0.00	326.50	326.50	5979.00	32471.75	5050.25	825.75
0.4	1.0	0.05	0	3301669.50	0.40	1731.50	984.00	576.50	984.00	407.50	4853.51	3129.25	986.00	387.25	986.00	598.75	8335.55	42839.75	998.50	998.50
0.4	1.0	0.05	1	2783676.50	0.80	0.00	984.00	0.00	251.00	251.00	4841.69	0.00	986.00	0.00	355.50	355.50	6686.47	293.25	998.50	458.50
0.4	1.0	0.05	2	3337935.00	0.63	12.75	984.00	0.00	307.50	307.50	5702.90	4.00	986.00	0.00	372.00	372.00	7160.63	19603.00	998.50	681.75
0.4	1.0	0.1	0	2591114.25	0.31	475.00	499.25	154.75	499.25	344.50	4970.28	868.50	506.50	91.50	506.50	415.00	6578.59	17549.75	484.00	484.00
0.4	1.0	0.1	1	2579674.75	0.82	22.25	499.25	5.75	299.75	294.00	5420.01	16.75	506.50	0.00	350.00	350.00	6815.19	56.50	484.00	359.25
0.4	1.0	0.1	2	3241785.00	0.51	194.75	499.25	48.25	422.00	373.75	6904.96	142.75	506.50	3.50	438.25	434.75	8395.74	1839.75	484.00	473.00

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF drops	EF ctotal	EF cfail	EF cacc	EF csuc	EF ssuc	AF drops	AF ctotal	AF cfail	AF cacc	AF csuc	AF ssuc	BE drops	BE ctotal	BE cacc
0.5	0.3	0.005	0	8494860.00	0.98	23899.00	10042.00	9148.00	10042.00	894.00	3313.65	53346.50	10020.75	8096.50	10020.75	1924.25	13313.88	275365.25	10017.25	10017.25
0.5	0.3	0.005	1	6042928.25	0.95	0.00	10042.00	0.00	397.50	397.50	7585.35	17.25	10020.75	0.50	898.50	898.00	16332.75	1886.25	10017.25	1411.25
0.5	0.3	0.005	2	6276387.25	0.95	0.00	10042.00	0.00	427.50	427.50	8496.16	4.00	10020.75	0.25	622.00	621.75	11698.35	68609.00	10017.25	1960.25
0.5	0.3	0.01	0	8423442.25	0.98	10943.25	4969.50	4002.50	4969.50	967.00	6694.52	22444.75	4960.75	3232.50	4960.75	1728.25	16603.71	203422.25	4968.75	4968.75
0.5	0.3	0.01	1	6285408.50	0.96	0.00	4969.50	0.00	490.25	490.25	9348.50	0.00	4960.75	0.00	874.75	874.75	15791.02	1498.00	4968.75	1236.75
0.5	0.3	0.01	2	6192616.00	0.96	0.00	4969.50	0.00	438.75	438.75	8538.09	3.50	4960.75	0.25	616.00	615.75	11737.16	69458.25	4968.75	1855.00
0.5	0.3	0.05	0	6029108.50	0.72	925.25	1004.00	268.50	1004.00	735.50	11611.58	995.50	992.25	91.75	992.25	900.50	15494.97	21921.25	987.75	987.75
0.5	0.3	0.05	1	5153630.25	0.98	0.00	1004.00	0.00	564.25	564.25	11055.83	0.00	992.25	0.00	647.25	647.25	12458.88	307.00	987.75	729.00
0.5	0.3	0.05	2	6372646.50	0.88	96.00	1004.00	27.75	735.00	707.25	14379.05	13.00	992.25	0.00	771.00	771.00	15101.13	4734.00	987.75	923.25
0.5	0.3	0.1	0	3735253.50	0.44	24.50	514.75	11.00	514.75	503.75	8663.26	0.00	501.25	0.00	501.25	501.25	9715.83	237.25	494.50	494.50
0.5	0.3	0.1	1	3527981.75	0.94	0.00	514.75	0.00	475.75	475.75	8334.57	0.00	501.25	0.00	468.50	468.50	9168.27	1.50	494.50	474.50
0.5	0.3	0.1	2	3768902.25	0.46	0.00	514.75	0.00	514.75	514.75	8938.22	0.00	501.25	0.00	501.25	501.25	9715.83	4.25	494.50	494.50
0.5	0.4	0.005	0	8458018.50	0.98	23637.75	9941.75	9067.50	9941.75	874.25	2917.26	52776.50	10000.75	8050.00	10000.75	1950.75	13050.11	277489.25	9925.50	9925.50
0.5	0.4	0.005	1	6074324.25	0.95	0.00	9941.75	0.00	383.50	383.50	7509.84	0.00	10000.75	0.00	866.50	866.50	15398.41	2225.50	9925.50	1377.50
0.5	0.4	0.005	2	6324170.75	0.95	0.00	9941.75	0.00	430.25	430.25	7988.61	0.00	10000.75	0.00	630.50	630.50	11439.24	70011.50	9925.50	1979.75
0.5	0.4	0.01	0	8434257.25	0.98	10576.75	4951.25	3944.50	4951.25	1006.75	6432.87	22868.75	5083.75	3306.50	5083.75	1777.25	17332.83	205361.25	4963.25	4963.25
0.5	0.4	0.01	1	6250629.75	0.96	0.00	4951.25	0.00	466.25	466.25	8887.00	0.00	5083.75	0.00	881.00	881.00	16749.61	1865.50	4963.25	1227.25
0.5	0.4	0.01	2	6122133.00	0.96	0.00	4951.25	0.00	425.25	425.25	8122.42	0.00	5083.75	0.00	646.75	646.75	11677.07	72725.25	4963.25	1823.50
0.5	0.4	0.05	0	5879674.00	0.70	750.00	968.25	217.50	968.25	750.75	12555.60	930.50	965.75	85.00	965.75	880.75	16412.24	24519.75	991.00	991.00
0.5	0.4	0.05	1	5053043.75	0.97	0.00	968.25	0.00	551.50	551.50	10757.66	8.50	965.75	0.00	648.75	648.75	12694.42	289.75	991.00	728.00
0.5	0.4	0.05	2	6311830.25	0.88	135.00	968.25	29.25	742.75	713.50	13890.75	69.25	965.75	2.75	777.00	774.25	15947.92	3796.75	991.00	944.50
0.5	0.4	0.1	0	3738174.75	0.44	112.25	508.00	32.25	508.00	475.75	8634.01	0.00	490.50	0.00	490.50	490.50	8543.36	543.50	489.25	489.25
0.5	0.4	0.1	1	3680014.00	0.95	0.00	508.00	0.00	477.00	477.00	9042.92	0.00	490.50	0.00	467.25	467.25	8162.52	9.75	489.25	473.75
0.5	0.4	0.1	2	3862038.25	0.48	0.00	508.00	0.00	508.00	508.00	9532.64	0.00	490.50	0.00	490.50	490.50	8543.36	10.00	489.25	489.25
0.5	0.5	0.005	0	8447828.00	0.98	23887.75	10043.75	9179.25	10043.75	864.50	2931.35	52747.00	10010.50	8033.00	10010.50	1977.50	13401.47	274395.25	9979.75	9979.75
0.5	0.5	0.005	1	6189931.25	0.96	0.00	10043.75	0.00	414.00	414.00	8267.93	0.75	10010.50	0.00	883.25	883.25	16158.01	1311.75	9979.75	1374.25
0.5	0.5	0.005	2	6258635.50	0.95	0.00	10043.75	0.00	441.50	441.50	8056.47	0.00	10010.50	0.00	622.50	622.50	11335.32	68865.50	9979.75	1929.00
0.5	0.5	0.01	0	8433653.50	0.98	10915.25	5006.25	3991.75	5006.25	1014.50	6520.74	22560.75	5009.00	3254.50	5009.00	1754.50	16920.33	202600.50	4988.50	4988.50
0.5	0.5	0.01	1	6420665.25	0.97	0.00	5006.25	0.00	515.50	515.50	9968.10	0.00	5009.00	0.00	859.50	859.50	16132.79	1512.00	4988.50	1206.25
0.5	0.5	0.01	2	6149542.00	0.95	0.00	5006.25	0.00	429.00	429.00	8082.34	0.00	5009.00	0.00	616.50	616.50	11477.42	68372.25	4988.50	1812.00
0.5	0.5	0.05	0	5909609.00	0.69	795.75	1005.50	241.25	1005.50	764.25	12124.93	1040.50	985.75	108.50	985.75	877.25	15097.86	25242.00	1003.00	1003.00
0.5	0.5	0.05	1	4942080.75	0.97	0.00	1005.50	0.00	554.25	554.25	10293.99	30.50	985.75	1.50	622.00	620.50	11594.16	256.75	1003.00	703.00
0.5	0.5	0.05	2	5995445.50	0.86	357.25	1005.50	91.25	761.75	670.50	12930.23	130.00	985.75	1.75	773.50	771.75	14838.09	4528.75	1003.00	944.25
0.5	0.5	0.1	0	3583490.25	0.42	124.50	510.25	30.75	510.25	479.50	8100.99	81.00	516.25	6.25	516.25	510.00	9159.72	3242.00	490.00	490.00
0.5	0.5	0.1	1	3584952.00	0.93	0.00	510.25	0.00	467.50	467.50	8715.23	3.50	516.25	0.00	474.00	474.00	8588.61	15.50	490.00	470.75
0.5	0.5	0.1	2	3816907.75	0.48	0.00	510.25	0.00	510.25	510.25	9341.34	0.00	516.25	0.00	516.25	516.25	9270.78	14.25	490.00	490.00
0.5	0.6	0.005	0	8421041.25	0.98	23882.75	9947.75	9124.25	9947.75	823.50	3139.59	53613.25	10031.25	8038.25	10031.25	1993.00	14374.57	268831.50	9983.25	9983.25
0.5	0.6	0.005	1	6288312.25	0.96	0.00	9947.75	0.00	440.50	440.50	9015.98	0.00	10031.25	0.00	882.50	882.50	16602.75	1907.75	9983.25	1349.25
0.5	0.6	0.005	2	6202412.75	0.95	0.00	9947.75	0.00	420.50	420.50	7842.68	0.00	10031.25	0.00	632.00	632.00	11998.54	68523.50	9983.25	1920.25
0.5	0.6	0.01	0	8352777.25	0.98	10913.75	4997.00	4013.00	4997.00	984.00	7040.24	22442.25	4987.00	3247.50	4987.00	1739.50	17720.99	192674.50	4952.25	4952.25
0.5	0.6	0.01	1	6383957.00	0.97	0.00	4997.00	0.00	522.50	522.50	10181.26	0.25	4987.00	0.00	866.75	866.75	16340.99	1551.50	4952.25	1193.50
0.5	0.6	0.01	2	6129517.75	0.95	0.00	4997.00	0.00	435.00	435.00	8506.77	0.00	4987.00	0.00	621.00	621.00	11590.35	65078.00	4952.25	1768.50
0.5	0.6	0.05	0	5582516.25	0.65	782.25	997.75	280.25	997.75	717.50	11501.28	1300.00	971.50	158.75	971.50	812.75	13065.95	23609.75	1009.50	1009.50
0.5	0.6	0.05	1	4854961.25	0.97	0.00	997.75	0.00	538.50	538.50	10347.35	6.75	971.50	0.00	591.75	591.75	10826.90	304.75	1009.50	693.50
0.5	0.6	0.05	2	5937055.00	0.87	142.50	997.75	17.00	701.00	684.00	13330.08	39.75	971.50	0.25	688.75	688.50	13200.16	7329.25	1009.50	920.25
0.5	0.6	0.1	0	3359330.00	0.40	269.25	501.75	72.25	501.75	429.50	7370.05	244.00	477.25	25.00	477.25	452.25	8083.08	8716.00	502.00	502.00
0.5	0.6	0.1	1	3409284.00	0.91	0.00	501.75	0.00	445.75	445.75	8148.26	19.00	477.25	0.75	428.00	427.25	7796.18	13.00	502.00	466.75
0.5	0.6	0.1	2	3723554.50	0.48	26.75	501.75	3.50	501.75	498.25	9020.15	90.25	477.25	5.00	477.25	472.25	8500.84	21.50	502.00	502.00

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.5	0.7	0.005	0	8378832.00	0.98	23644.25	9962.00	9097.25	9962.00	864.75	3869.61	53199.50	10041.75	7963.50	10041.75	2078.25	15758.98	258209.25	10007.25	10007.25
0.5	0.7	0.005	1	6214305.00	0.96	0.00	9962.00	0.00	428.75	428.75	7979.28	0.00	10041.75	0.00	871.00	871.00	16436.04	2263.50	10007.25	1306.50
0.5	0.7	0.005	2	6119166.50	0.95	0.00	9962.00	0.00	435.75	435.75	8277.23	0.00	10041.75	0.00	604.25	604.25	11242.41	64224.00	10007.25	1817.75
0.5	0.7	0.01	0	8351727.00	0.98	10764.75	4982.50	3972.25	4982.50	1010.25	8110.56	23077.50	5022.00	3343.25	5022.00	1678.75	18524.88	181136.50	4983.25	4983.25
0.5	0.7	0.01	1	6186560.25	0.97	0.00	4982.50	0.00	503.00	503.00	9362.82	0.00	5022.00	0.00	842.50	842.50	15961.61	1543.00	4983.25	1172.00
0.5	0.7	0.01	2	5912945.75	0.95	0.00	4982.50	0.00	438.75	438.75	7944.30	0.00	5022.00	0.00	604.00	604.00	11618.25	59616.00	4983.25	1687.75
0.5	0.7	0.05	0	4962221.00	0.58	898.00	995.00	313.25	995.00	681.75	10656.14	1840.50	991.75	234.00	991.75	757.75	11639.86	25134.75	998.50	998.50
0.5	0.7	0.05	1	4380598.50	0.95	0.00	995.00	0.00	522.25	522.25	9861.37	16.75	991.75	0.25	568.25	568.00	10359.68	191.25	998.50	634.50
0.5	0.7	0.05	2	5443743.00	0.84	72.75	995.00	1.50	631.50	630.00	12003.59	4.25	991.75	0.00	647.75	647.75	11767.83	9324.25	998.50	882.25
0.5	0.7	0.1	0	3207296.50	0.38	309.25	516.00	87.25	516.00	428.75	7053.97	503.50	507.00	38.75	507.00	468.25	8111.28	12337.50	498.25	498.25
0.5	0.7	0.1	1	3258897.25	0.90	0.00	516.00	0.00	414.75	414.75	7600.62	0.25	507.00	0.00	420.50	420.50	7807.41	13.50	498.25	433.00
0.5	0.7	0.1	2	3826247.25	0.51	27.00	516.00	11.75	516.00	504.25	9325.60	135.00	507.00	5.75	506.50	500.75	9014.49	54.50	498.25	498.25
0.5	0.8	0.005	0	8365701.75	0.98	23716.75	9961.75	9070.00	9961.75	891.75	5484.11	53709.00	10111.50	8052.25	10111.50	2059.25	17920.89	233018.50	9975.50	9975.50
0.5	0.8	0.005	1	6163565.50	0.97	0.00	9961.75	0.00	447.50	447.50	8887.90	0.00	10111.50	0.00	853.50	853.50	16137.85	1988.25	9975.50	1205.00
0.5	0.8	0.005	2	5938303.50	0.95	0.00	9961.75	0.00	408.50	408.50	8007.44	0.00	10111.50	0.00	612.50	612.50	11609.88	57925.00	9975.50	1754.00
0.5	0.8	0.01	0	8097404.75	0.95	10872.75	4993.00	4069.75	4993.00	923.25	8990.67	23318.75	4986.00	3436.00	4986.00	1550.00	17843.85	139364.25	4965.50	4965.50
0.5	0.8	0.01	1	5855373.50	0.97	0.00	4993.00	0.00	500.25	500.25	9633.18	0.00	4986.00	0.00	749.50	749.50	13711.99	1261.00	4965.50	988.00
0.5	0.8	0.01	2	5739753.75	0.95	0.00	4993.00	0.00	418.00	418.00	7697.67	0.00	4986.00	0.00	573.50	573.50	11003.47	54210.00	4965.50	1546.25
0.5	0.8	0.05	0	4472704.00	0.52	1148.00	989.25	407.50	989.25	581.75	8658.70	2265.25	996.75	306.00	996.75	690.75	11004.25	28133.00	996.75	996.75
0.5	0.8	0.05	1	4033498.25	0.93	0.00	989.25	0.00	451.25	451.25	8395.50	1.50	996.75	0.00	510.75	510.75	9886.03	303.25	996.75	580.50
0.5	0.8	0.05	2	4818322.75	0.79	92.50	989.25	5.75	547.75	542.00	10214.72	73.25	996.75	1.00	591.75	590.75	11699.24	13204.50	996.75	818.00
0.5	0.8	0.1	0	2883933.00	0.34	425.25	505.50	118.50	505.50	387.00	6017.97	780.75	507.00	74.25	507.00	432.75	7149.22	13140.50	501.00	501.00
0.5	0.8	0.1	1	2934386.75	0.87	0.00	505.50	0.00	361.00	361.00	6801.89	21.75	507.00	1.00	389.25	388.25	7239.59	22.50	501.00	405.25
0.5	0.8	0.1	2	3698586.50	0.52	86.00	505.50	29.25	495.00	465.75	8397.88	172.75	507.00	5.50	496.75	491.25	8931.50	520.00	501.00	500.25
0.5	0.9	0.005	0	8013408.00	0.95	23991.75	10067.25	9249.50	10067.25	817.75	7356.02	53596.50	10045.25	8104.25	10045.25	1941.00	20450.90	170691.75	9969.75	9969.75
0.5	0.9	0.005	1	5952683.50	0.97	0.00	10067.25	0.00	481.00	481.00	8861.23	0.00	10045.25	0.00	784.50	784.50	14561.47	1732.00	9969.75	1040.50
0.5	0.9	0.005	2	5707008.50	0.94	0.00	10067.25	0.00	414.50	414.50	8030.70	0.00	10045.25	0.00	569.75	569.75	10332.31	45442.25	9969.75	1561.00
0.5	0.9	0.01	0	6779625.25	0.80	11188.00	4999.50	4227.50	4999.50	772.00	9010.43	24719.25	5018.00	3740.50	5018.00	1277.50	13784.42	112548.75	5007.25	5007.25
0.5	0.9	0.01	1	4954954.50	0.95	0.00	4999.50	0.00	479.75	479.75	9122.01	0.00	5018.00	0.00	647.75	647.75	11585.30	552.00	5007.25	893.25
0.5	0.9	0.01	2	5408586.25	0.93	0.00	4999.50	0.00	436.50	436.50	8394.97	0.00	5018.00	0.00	544.00	544.00	9543.26	41578.75	5007.25	1416.50
0.5	0.9	0.05	0	3891343.50	0.45	1360.25	946.00	495.00	946.00	451.00	6088.06	2514.75	973.25	338.75	973.25	634.50	9002.05	32391.50	1023.50	1023.50
0.5	0.9	0.05	1	3437129.75	0.87	0.00	946.00	0.00	355.00	355.00	6516.20	0.00	973.25	0.00	424.00	424.00	7698.33	311.25	1023.50	543.50
0.5	0.9	0.05	2	4049999.75	0.70	74.25	946.00	5.00	406.00	401.00	7329.76	2.50	973.25	0.00	469.25	469.25	9061.64	19108.75	1023.50	757.50
0.5	0.9	0.1	0	2623338.00	0.31	484.75	496.50	159.25	496.50	337.25	5058.27	838.00	493.25	89.75	493.25	403.50	6538.49	16410.75	475.75	475.75
0.5	0.9	0.1	1	2604765.00	0.84	0.00	496.50	0.00	305.75	305.75	5533.77	0.25	493.25	0.00	342.75	342.75	6474.23	32.25	475.75	356.00
0.5	0.9	0.1	2	3398909.50	0.50	209.50	496.50	59.75	472.75	413.00	7326.68	187.25	493.25	4.50	469.50	465.00	8732.94	780.00	475.75	471.25
0.5	1.0	0.005	0	3406416.25	0.41	25359.00	9991.75	9719.25	9991.75	272.50	485.46	56673.50	9910.25	8677.25	9910.25	1233.00	8183.50	137883.25	9952.25	9952.25
0.5	1.0	0.005	1	2309373.25	0.74	0.00	9991.75	0.00	120.75	120.75	2361.05	0.00	9910.25	0.00	342.50	342.50	6380.82	697.00	9952.25	564.00
0.5	1.0	0.005	2	3013109.25	0.63	0.00	9991.75	0.00	218.50	218.50	3854.63	3.50	9910.25	0.00	328.00	328.00	6393.00	29965.50	9952.25	854.25
0.5	1.0	0.01	0	3356438.00	0.40	11873.75	4981.00	4664.50	4981.00	316.50	1008.85	27299.00	4982.75	4121.25	4982.75	861.50	6024.23	114826.50	5012.00	5012.00
0.5	1.0	0.01	1	2416855.25	0.73	0.00	4981.00	0.00	153.50	153.50	2871.07	0.00	4982.75	0.00	357.75	357.75	6386.30	581.00	5012.00	527.00
0.5	1.0	0.01	2	3046627.50	0.63	0.00	4981.00	0.00	213.25	213.25	3850.90	3.25	4982.75	0.25	298.50	298.25	5501.60	34235.00	5012.00	836.25
0.5	1.0	0.05	0	3173975.75	0.38	1833.00	1008.00	633.75	1008.00	374.25	4321.88	3116.75	990.25	444.00	990.25	546.25	7522.69	37763.50	1014.50	1014.50
0.5	1.0	0.05	1	2679119.50	0.79	0.00	1008.00	0.00	254.75	254.75	5504.03	34.50	990.25	1.00	347.75	346.75	6165.06	201.50	1014.50	439.50
0.5	1.0	0.05	2	3349729.25	0.62	0.00	1008.00	0.00	299.50	299.50	5762.27	1.50	990.25	0.25	346.00	345.75	6203.58	20725.75	1014.50	658.50
0.5	1.0	0.1	0	2436168.00	0.28	525.25	487.75	171.75	487.75	316.00	4206.13	876.25	473.75	102.25	473.75	371.50	6109.20	18671.50	491.00	491.00
0.5	1.0	0.1	1	2541040.50	0.82	0.00	487.75	0.00	281.00	281.00	5185.15	20.75	473.75	0.75	317.75	317.00	6062.66	30.75	491.00	359.50
0.5	1.0	0.1	2	3204399.00	0.51	258.00	487.75	62.50	415.50	353.00	6350.64	130.25	473.75	3.25	419.50	416.25	8279.34	1914.25	491.00	477.75

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.6	0.3	0.005	0	8651076.75	0.98	23864.75	10065.25	9205.25	10065.25	860.00	3868.03	52972.50	9987.75	8004.00	9987.75	1983.75	14228.25	271138.00	9975.25	9975.25
0.6	0.3	0.005	1	6143733.00	0.95	0.00	10065.25	0.00	405.50	405.50	7913.50	0.00	9987.75	0.00	887.75	887.75	16242.73	1623.75	9975.25	1313.50
0.6	0.3	0.005	2	6275186.50	0.95	0.00	10065.25	0.00	419.25	419.25	7975.95	1.25	9987.75	0.00	608.25	608.25	11099.71	71296.50	9975.25	1920.50
0.6	0.3	0.01	0	8518690.75	0.97	10903.25	4980.50	4017.50	4980.50	963.00	6765.90	22770.75	5054.25	3319.75	5054.25	1734.50	16960.08	192947.75	5020.25	5020.25
0.6	0.3	0.01	1	6317376.75	0.97	0.00	4980.50	0.00	483.25	483.25	9164.93	0.00	5054.25	0.00	845.25	845.25	15871.42	1399.00	5020.25	1189.00
0.6	0.3	0.01	2	6144296.25	0.96	0.00	4980.50	0.00	399.50	399.50	7553.66	0.00	5054.25	0.00	623.25	623.25	11703.06	67241.25	5020.25	1797.25
0.6	0.3	0.05	0	5788147.75	0.67	950.00	1000.50	269.00	1000.50	731.50	10998.66	1194.00	993.00	107.75	993.00	885.25	15289.76	28875.50	1037.25	1037.25
0.6	0.3	0.05	1	5161838.75	0.97	0.00	1000.50	0.00	558.00	558.00	10537.85	0.50	993.00	0.00	638.00	638.00	12220.33	345.50	1037.25	748.75
0.6	0.3	0.05	2	6229589.75	0.87	89.00	1000.50	15.75	721.75	706.00	14020.84	46.00	993.00	1.25	734.25	733.00	14625.99	5673.50	1037.25	971.50
0.6	0.3	0.1	0	3828761.75	0.43	19.75	500.00	7.25	500.00	492.75	8757.92	0.00	501.25	0.00	501.25	501.25	9732.51	79.25	496.25	496.25
0.6	0.3	0.1	1	3591712.00	0.93	0.00	500.00	0.00	455.25	455.25	8262.66	0.00	501.25	0.00	466.50	466.50	9221.72	2.25	496.25	472.75
0.6	0.3	0.1	2	3845146.50	0.46	0.00	500.00	0.00	500.00	500.00	8980.63	0.00	501.25	0.00	501.25	501.25	9732.51	0.25	496.25	496.25
0.6	0.4	0.005	0	8602031.75	0.98	23565.25	10000.00	9134.50	10000.00	865.50	3468.14	52412.50	9928.75	7926.25	9928.75	2002.50	14452.96	274511.25	10103.75	10103.75
0.6	0.4	0.005	1	6209649.00	0.95	0.00	10000.00	0.00	411.75	411.75	7693.87	0.00	9928.75	0.00	883.50	883.50	16761.99	2025.00	10103.75	1345.50
0.6	0.4	0.005	2	6207644.75	0.95	0.00	10000.00	0.00	425.50	425.50	8203.79	0.00	9928.75	0.00	599.50	599.50	10492.74	68319.50	10103.75	1925.50
0.6	0.4	0.01	0	8524574.25	0.97	10734.00	4991.50	3955.00	4991.50	1036.50	7095.06	22370.25	4987.25	3219.00	4987.25	1768.25	18279.31	198964.50	5021.50	5021.50
0.6	0.4	0.01	1	6236750.25	0.96	0.00	4991.50	0.00	470.75	470.75	8962.87	0.00	4987.25	0.00	806.75	806.75	15639.83	1866.00	5021.50	1187.50
0.6	0.4	0.01	2	6170014.00	0.96	0.00	4991.50	0.00	404.00	404.00	7274.16	1.00	4987.25	0.00	594.25	594.25	11030.65	68192.75	5021.50	1842.50
0.6	0.4	0.05	0	5627009.00	0.65	977.25	999.25	267.25	999.25	732.00	11206.99	1210.50	983.00	126.50	983.00	856.50	14225.85	25335.50	1007.75	1007.75
0.6	0.4	0.05	1	5074293.25	0.97	0.00	999.25	0.00	572.75	572.75	11275.41	6.50	983.00	0.00	644.50	644.50	11838.92	209.00	1007.75	723.50
0.6	0.4	0.05	2	6185843.25	0.86	243.75	999.25	62.75	777.25	714.50	13329.78	92.25	983.00	1.25	782.25	781.00	14774.12	4237.75	1007.75	961.00
0.6	0.4	0.1	0	3763836.25	0.42	92.75	504.00	25.50	504.00	478.50	8561.94	33.50	520.00	1.00	520.00	519.00	9082.67	938.25	504.00	504.00
0.6	0.4	0.1	1	3640705.00	0.93	0.00	504.00	0.00	463.25	463.25	8576.15	0.00	520.00	0.00	488.25	488.25	8669.70	1.75	504.00	483.50
0.6	0.4	0.1	2	3862933.50	0.46	0.00	504.00	0.00	504.00	504.00	9340.07	29.00	520.00	2.75	520.00	517.25	9035.60	0.25	504.00	504.00
0.6	0.5	0.005	0	8610439.75	0.98	23787.25	10002.00	9118.50	10002.00	883.50	3694.09	52995.00	10005.75	7999.75	10005.75	2006.00	14541.90	271335.50	9938.75	9938.75
0.6	0.5	0.005	1	6053157.50	0.95	0.00	10002.00	0.00	416.50	416.50	7918.81	0.00	10005.75	0.00	883.50	883.50	16194.21	2445.50	9938.75	1323.75
0.6	0.5	0.005	2	6226580.25	0.95	0.00	10002.00	0.00	406.25	406.25	7790.88	0.00	10005.75	0.00	632.25	632.25	11623.84	70793.00	9938.75	1940.75
0.6	0.5	0.01	0	8528991.25	0.98	10994.75	5018.25	4016.25	5018.25	1002.00	7156.40	22303.75	5001.50	3223.50	5001.50	1778.00	18388.37	198027.50	4951.25	4951.25
0.6	0.5	0.01	1	6266806.00	0.97	0.00	5018.25	0.00	528.75	528.75	9303.74	0.00	5001.50	0.00	834.25	834.25	15646.65	1351.50	4951.25	1188.75
0.6	0.5	0.01	2	6087904.75	0.96	0.00	5018.25	0.00	425.75	425.75	7988.17	0.50	5001.50	0.00	594.50	594.50	11390.70	66072.25	4951.25	1812.50
0.6	0.5	0.05	0	5575832.75	0.65	930.75	990.75	294.00	990.75	696.75	10977.49	1539.00	1000.50	178.50	1000.50	822.00	13731.48	27434.50	969.25	969.25
0.6	0.5	0.05	1	4857002.25	0.97	20.50	990.75	4.25	554.00	549.75	10239.72	27.00	1000.50	0.75	618.75	618.00	11626.48	201.50	969.25	677.50
0.6	0.5	0.05	2	6133888.75	0.88	173.50	990.75	52.25	736.75	684.50	12899.14	133.25	1000.50	4.25	751.25	747.00	14527.52	4867.00	969.25	902.00
0.6	0.5	0.1	0	3469493.00	0.40	254.50	504.00	59.00	504.00	445.00	7412.33	208.50	514.25	23.25	514.25	491.00	8795.05	3738.00	487.00	487.00
0.6	0.5	0.1	1	3595639.75	0.93	10.75	504.00	0.00	450.50	450.50	8510.50	6.00	514.25	0.00	466.75	466.75	8440.83	0.50	487.00	454.50
0.6	0.5	0.1	2	3898728.75	0.49	0.00	504.00	0.00	504.00	504.00	9279.99	97.75	514.25	3.50	514.25	510.75	9181.87	9.75	487.00	487.00
0.6	0.6	0.005	0	8564138.75	0.98	23756.50	9953.50	9054.50	9953.50	899.00	3817.69	52985.50	10011.75	7978.25	10011.75	2033.50	14965.58	266062.50	10063.25	10063.25
0.6	0.6	0.005	1	6023525.25	0.95	0.00	9953.50	0.00	383.75	383.75	7458.60	0.00	10011.75	0.00	819.50	819.50	15056.33	2006.25	10063.25	1273.25
0.6	0.6	0.005	2	6202811.25	0.95	0.00	9953.50	0.00	437.75	437.75	8193.54	0.00	10011.75	0.00	616.00	616.00	11478.87	68009.25	10063.25	1884.25
0.6	0.6	0.01	0	8553870.75	0.98	10803.75	4988.25	3966.50	4988.25	1021.75	8214.88	22716.00	5006.25	3264.00	5006.25	1742.25	18425.35	187089.50	5006.75	5006.75
0.6	0.6	0.01	1	6351108.25	0.97	0.00	4988.25	0.00	493.00	493.00	9606.11	0.00	5006.25	0.00	838.00	838.00	15856.61	1542.00	5006.75	1166.50
0.6	0.6	0.01	2	5970451.25	0.95	0.00	4988.25	0.00	421.50	421.50	7535.13	0.00	5006.25	0.00	601.75	601.75	10908.34	63886.25	5006.75	1764.00
0.6	0.6	0.05	0	5283637.00	0.60	945.75	1005.25	313.50	1005.25	691.75	10704.18	1575.50	1002.50	187.00	1002.50	815.50	13276.59	24406.25	993.25	993.25
0.6	0.6	0.05	1	4740503.25	0.97	0.00	1005.25	0.00	545.75	545.75	10483.82	0.00	1002.50	0.00	619.75	619.75	11426.68	191.75	993.25	658.25
0.6	0.6	0.05	2	5955052.25	0.88	143.00	1005.25	17.75	696.50	678.75	12658.12	26.75	1002.50	0.75	730.00	729.25	14060.15	6082.00	993.25	905.75
0.6	0.6	0.1	0	3191873.75	0.37	280.50	486.50	72.25	486.50	414.25	7088.87	399.75	505.00	39.50	505.00	465.50	8033.68	13507.50	513.75	513.75
0.6	0.6	0.1	1	3133649.00	0.90	0.00	486.50	0.00	392.50	392.50	7501.63	3.75	505.00	0.00	415.75	415.75	7825.57	11.25	513.75	450.50
0.6	0.6	0.1	2	3708785.00	0.49	0.00	486.50	0.00	486.50	486.50	9271.44	147.25	505.00	8.25	505.00	496.75	9287.31	56.25	513.75	513.75

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF drops	EF ctotal	EF cfail	EF cacc	EF csuc	EF ssuc	AF drops	AF ctotal	AF cfail	AF cacc	AF csuc	AF ssuc	BE drops	BE ctotal	BE cacc
0.6	0.7	0.005	0	8547715.75	0.98	23786.00	9967.00	9063.50	9967.00	903.50	4711.94	52032.50	9922.75	7852.50	9922.75	2070.25	17103.10	253461.50	10013.50	10013.50
0.6	0.7	0.005	1	6162410.25	0.96	0.00	9967.00	0.00	426.00	426.00	8378.95	0.00	9922.75	0.00	852.75	852.75	15599.95	1713.25	10013.50	1274.25
0.6	0.7	0.005	2	6063961.75	0.95	0.00	9967.00	0.00	409.50	409.50	7678.47	0.00	9922.75	0.00	606.50	606.50	11418.26	66394.75	10013.50	1847.75
0.6	0.7	0.01	0	8417339.50	0.97	10719.25	5058.75	4034.25	5058.75	1024.50	8394.66	22916.75	4990.00	3299.50	4990.00	1690.50	19402.06	168257.50	5056.75	5056.75
0.6	0.7	0.01	1	6020124.75	0.97	0.00	5058.75	0.00	519.50	519.50	9656.10	2.00	4990.00	0.00	797.00	797.00	14713.45	1445.50	5056.75	1149.50
0.6	0.7	0.01	2	5941354.25	0.95	11.75	5058.75	0.00	427.75	427.75	8355.41	0.00	4990.00	0.00	590.25	590.25	11164.37	58093.75	5056.75	1702.75
0.6	0.7	0.05	0	4879539.75	0.55	1095.00	995.25	385.00	995.25	610.25	9403.67	2021.25	980.25	260.50	980.25	719.75	11405.44	25999.75	983.75	983.75
0.6	0.7	0.05	1	4356481.50	0.95	0.00	995.25	0.00	490.75	490.75	9154.68	0.00	980.25	0.00	549.50	549.50	10277.19	152.75	983.75	621.50
0.6	0.7	0.05	2	5564117.50	0.85	48.25	995.25	11.75	612.00	600.25	11072.76	41.50	980.25	0.00	630.00	630.00	12217.18	9653.25	983.75	849.50
0.6	0.7	0.1	0	2940908.75	0.34	392.25	498.50	120.75	498.50	377.75	6158.05	560.50	492.75	56.75	492.75	436.00	7513.43	15478.00	509.00	509.00
0.6	0.7	0.1	1	2980384.75	0.88	0.00	498.50	0.00	364.00	364.00	6907.80	0.00	492.75	0.00	374.75	374.75	6923.48	36.75	509.00	414.00
0.6	0.7	0.1	2	3765278.00	0.50	35.25	498.50	10.00	497.25	487.25	8932.16	123.50	492.75	5.75	492.25	486.50	8833.25	142.75	509.00	508.75
0.6	0.8	0.005	0	8494930.00	0.98	23224.75	9923.50	8996.25	9923.50	927.25	6021.46	52273.25	10003.50	7893.00	10003.50	2110.50	19496.42	227199.50	10009.00	10009.00
0.6	0.8	0.005	1	6205901.25	0.96	0.00	9923.50	0.00	477.75	477.75	9125.27	0.25	10003.50	0.00	866.00	866.00	16386.11	1846.25	10009.00	1260.25
0.6	0.8	0.005	2	5980116.25	0.95	0.00	9923.50	0.00	421.00	421.00	7822.35	0.00	10003.50	0.00	601.25	601.25	11276.11	55853.75	10009.00	1761.75
0.6	0.8	0.01	0	8264669.00	0.94	11015.25	5092.25	4124.25	5092.25	968.00	10212.76	23906.00	5060.00	3498.75	5060.00	1561.25	18968.81	141678.00	4988.50	4988.50
0.6	0.8	0.01	1	5995204.50	0.97	0.00	5092.25	0.00	541.00	541.00	10000.84	3.00	5060.00	0.25	799.25	799.00	15140.67	1174.50	4988.50	1027.50
0.6	0.8	0.01	2	5764093.75	0.95	0.00	5092.25	0.00	433.75	433.75	7999.56	0.00	5060.00	0.00	579.75	579.75	10805.13	51627.00	4988.50	1564.50
0.6	0.8	0.05	0	4255455.00	0.48	1253.25	1025.75	462.00	1025.75	563.75	8702.45	2574.50	1024.00	353.25	1024.00	670.75	10128.38	27763.00	1003.25	1003.25
0.6	0.8	0.05	1	3928802.75	0.92	0.00	1025.75	0.00	460.75	460.75	9019.05	19.50	1024.00	0.50	506.25	505.75	9648.30	185.75	1003.25	564.25
0.6	0.8	0.05	2	4896358.75	0.78	67.50	1025.75	2.75	541.75	539.00	10519.61	27.50	1024.00	0.25	573.50	573.25	10993.18	13369.50	1003.25	811.00
0.6	0.8	0.1	0	2659685.50	0.31	452.75	500.50	146.25	500.50	354.25	5499.82	961.75	527.25	103.25	527.25	424.00	6616.27	16076.75	478.50	478.50
0.6	0.8	0.1	1	2803882.75	0.87	0.00	500.50	0.00	329.75	329.75	6246.98	45.50	527.25	2.75	386.50	383.75	6895.88	6.25	478.50	374.00
0.6	0.8	0.1	2	3555048.25	0.51	146.75	500.50	56.25	495.75	439.50	7860.68	282.25	527.25	17.75	521.25	503.50	8994.60	222.75	478.50	478.50
0.6	0.9	0.005	0	8165570.75	0.93	24215.00	10047.25	9152.25	10047.25	895.00	9226.69	52879.75	10002.25	8038.50	10002.25	1963.75	20885.66	168682.00	9897.00	9897.00
0.6	0.9	0.005	1	5804477.50	0.97	0.00	10047.25	0.00	502.50	502.50	9884.50	0.00	10002.25	0.00	818.75	818.75	14977.97	1544.75	9897.00	1064.00
0.6	0.9	0.005	2	5689522.00	0.94	0.00	10047.25	0.00	436.50	436.50	8255.64	0.00	10002.25	0.00	590.50	590.50	10753.94	45841.25	9897.00	1537.25
0.6	0.9	0.01	0	6799483.00	0.79	11012.75	5006.25	4241.75	5006.25	764.50	8889.65	24894.25	5000.25	3724.25	5000.25	1276.00	15017.36	108319.75	4910.25	4910.25
0.6	0.9	0.01	1	5048002.25	0.96	0.00	5006.25	0.00	497.25	497.25	9420.68	0.00	5000.25	0.00	686.25	686.25	12889.03	669.00	4910.25	907.50
0.6	0.9	0.01	2	5456565.00	0.93	0.00	5006.25	0.00	449.50	449.50	8222.58	2.00	5000.25	0.25	564.25	564.00	10799.55	40477.00	4910.25	1378.25
0.6	0.9	0.05	0	3563552.75	0.41	1471.50	982.25	529.00	982.25	453.25	6236.43	2713.50	964.00	390.50	964.00	573.50	8158.19	30203.00	1028.75	1028.75
0.6	0.9	0.05	1	3252991.25	0.86	0.00	982.25	0.00	371.50	371.50	6686.60	0.00	964.00	0.00	414.50	414.50	7809.19	190.50	1028.75	515.00
0.6	0.9	0.05	2	4059408.75	0.69	0.00	982.25	0.00	413.00	413.00	7589.65	9.75	964.00	0.25	436.50	436.25	8156.11	18148.50	1028.75	752.50
0.6	0.9	0.1	0	2445386.00	0.29	527.75	507.25	170.75	507.25	336.50	4758.70	1034.75	518.25	113.75	518.25	404.50	6141.60	19715.75	509.50	509.50
0.6	0.9	0.1	1	2378062.25	0.82	0.00	507.25	0.00	280.25	280.25	4918.43	1.75	518.25	0.00	331.00	331.00	5869.48	23.00	509.50	353.00
0.6	0.9	0.1	2	3475041.50	0.52	125.75	507.25	26.50	471.25	444.75	7996.92	198.75	518.25	7.00	480.50	473.50	8744.89	1214.75	509.50	502.25
0.6	1.0	0.005	0	3394594.50	0.39	25788.75	10044.00	9759.00	10044.00	285.00	661.97	55987.50	9900.50	8586.00	9900.50	1314.50	9454.60	134811.75	9976.00	9976.00
0.6	1.0	0.005	1	2192666.75	0.74	0.00	10044.00	0.00	108.50	108.50	2218.36	0.00	9900.50	0.00	336.75	336.75	6238.26	908.25	9976.00	549.00
0.6	1.0	0.005	2	3098025.00	0.62	0.00	10044.00	0.00	220.50	220.50	4409.84	0.00	9900.50	0.00	322.00	322.00	6169.68	27851.25	9976.00	802.25
0.6	1.0	0.01	0	3370056.75	0.39	11805.00	4972.00	4661.00	4972.00	311.00	1329.52	27495.50	4994.75	4148.50	4994.75	846.25	6023.61	109461.00	5017.25	5017.25
0.6	1.0	0.01	1	2365011.00	0.73	0.00	4972.00	0.00	154.50	154.50	3010.84	0.00	4994.75	0.00	353.00	353.00	6404.96	503.50	5017.25	560.50
0.6	1.0	0.01	2	3055466.50	0.63	0.00	4972.00	0.00	216.75	216.75	4088.02	0.00	4994.75	0.00	309.25	309.25	5883.04	34605.25	5017.25	853.00
0.6	1.0	0.05	0	2990892.75	0.34	1794.75	1007.00	645.75	1007.00	361.25	4659.04	3345.50	997.75	486.00	997.75	511.75	6778.15	32728.50	994.75	994.75
0.6	1.0	0.05	1	2650676.75	0.80	0.00	1007.00	0.00	277.25	277.25	5193.35	0.00	997.75	0.00	337.75	337.75	6059.30	194.25	994.75	411.75
0.6	1.0	0.05	2	3309199.50	0.61	37.50	1007.00	0.25	312.25	312.00	5887.31	10.25	997.75	0.00	370.25	370.25	7036.18	20179.00	994.75	650.75
0.6	1.0	0.1	0	2140216.50	0.25	604.25	503.00	206.00	503.00	297.00	3919.41	1290.25	498.75	147.75	498.75	351.00	5293.33	20800.75	495.00	495.00
0.6	1.0	0.1	1	2077651.25	0.79	0.00	503.00	0.00	235.50	235.50	4340.96	6.25	498.75	0.00	270.00	270.00	5040.09	28.00	495.00	305.25
0.6	1.0	0.1	2	3225752.75	0.51	160.75	503.00	31.75	415.50	383.75	6721.45	140.25	498.75	2.75	414.75	412.00	7940.02	2323.00	495.00	473.75

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.7	0.3	0.005	0	8714778.75	0.98	23490.50	9938.25	9045.25	9938.25	893.00	4557.40	53255.50	10010.75	8022.75	10010.75	1988.00	16355.83	258534.00	9962.75	9962.75
0.7	0.3	0.005	1	6010603.50	0.96	0.00	9938.25	0.00	423.00	423.00	8445.56	0.00	10010.75	0.00	834.00	834.00	15738.74	1787.75	9962.75	1291.25
0.7	0.3	0.005	2	6083274.25	0.95	0.00	9938.25	0.00	401.75	401.75	7434.63	0.00	10010.75	0.00	597.75	597.75	10484.07	68669.75	9962.75	1895.50
0.7	0.3	0.01	0	8498562.25	0.95	10761.25	5017.25	4042.00	5017.25	975.25	8103.78	22734.25	5003.50	3330.00	5003.50	1673.50	17507.50	177779.25	4996.25	4996.25
0.7	0.3	0.01	1	6001099.00	0.97	0.00	5017.25	0.00	474.75	474.75	8639.47	0.00	5003.50	0.00	825.75	825.75	15422.78	1333.75	4996.25	1176.50
0.7	0.3	0.01	2	6055495.00	0.95	0.00	5017.25	0.00	415.00	415.00	7892.63	0.75	5003.50	0.00	615.50	615.50	11413.62	70152.00	4996.25	1798.00
0.7	0.3	0.05	0	5520198.50	0.63	1103.25	987.25	309.75	987.25	677.50	10280.93	1558.75	1006.75	154.75	1006.75	852.00	14551.33	36811.50	987.75	987.75
0.7	0.3	0.05	1	5108779.50	0.97	0.00	987.25	0.00	548.25	548.25	10109.14	2.25	1006.75	0.00	630.75	630.75	12574.76	295.75	987.75	709.75
0.7	0.3	0.05	2	6242341.75	0.88	60.50	987.25	7.75	680.25	672.50	13226.08	30.25	1006.75	0.50	706.00	705.50	14359.45	6674.25	987.75	916.25
0.7	0.3	0.1	0	3686448.00	0.41	55.50	498.25	18.50	498.25	479.75	8574.98	12.75	481.00	0.75	481.00	480.25	8008.42	327.25	495.25	495.25
0.7	0.3	0.1	1	3503594.50	0.93	0.00	498.25	0.00	455.25	455.25	8350.24	0.00	481.00	0.00	448.50	448.50	7491.42	2.75	495.25	471.25
0.7	0.3	0.1	2	3757560.25	0.45	0.00	498.25	0.00	498.25	498.25	8986.51	0.00	481.00	0.00	481.00	481.00	8008.42	0.00	495.25	495.25
0.7	0.4	0.005	0	8732726.25	0.98	23695.25	9922.00	8990.25	9922.00	931.75	4339.81	52987.00	9964.00	7982.50	9964.00	1981.50	15909.94	264900.00	9939.00	9939.00
0.7	0.4	0.005	1	6110261.50	0.96	0.00	9922.00	0.00	411.00	411.00	8201.46	0.00	9964.00	0.00	886.75	886.75	16511.38	1916.25	9939.00	1352.75
0.7	0.4	0.005	2	6112873.25	0.95	0.00	9922.00	0.00	417.75	417.75	7662.25	0.00	9964.00	0.00	609.25	609.25	11577.92	68151.25	9939.00	1975.50
0.7	0.4	0.01	0	8640412.25	0.97	10934.50	5017.75	4015.75	5017.75	1002.00	8673.17	22558.50	4994.00	3274.75	4994.00	1719.25	17902.66	183507.50	4982.75	4982.75
0.7	0.4	0.01	1	5990805.50	0.97	0.00	5017.75	0.00	461.75	461.75	8578.73	1.75	4994.00	0.00	816.75	816.75	15756.68	1401.50	4982.75	1146.25
0.7	0.4	0.01	2	6008694.50	0.95	0.00	5017.75	0.00	411.50	411.50	8109.35	0.00	4994.00	0.00	604.75	604.75	11071.90	66879.00	4982.75	1792.25
0.7	0.4	0.05	0	5547657.75	0.62	1011.50	1016.50	306.50	1016.50	710.00	10783.58	1516.75	1017.25	151.75	1017.25	865.50	15023.41	33697.00	1000.50	1000.50
0.7	0.4	0.05	1	5081183.75	0.97	0.00	1016.50	0.00	559.25	559.25	10692.35	1.00	1017.25	0.00	640.25	640.25	12120.27	186.50	1000.50	712.75
0.7	0.4	0.05	2	6019831.25	0.86	228.50	1016.50	43.00	749.75	706.75	13404.00	46.25	1017.25	1.00	766.25	765.25	15597.02	5849.25	1000.50	941.25
0.7	0.4	0.1	0	3549789.25	0.40	123.50	498.50	31.25	498.50	467.25	8397.41	86.75	520.50	10.00	520.50	510.50	8903.50	1856.75	488.00	488.00
0.7	0.4	0.1	1	3320303.75	0.91	0.00	498.50	0.00	425.25	425.25	8113.16	0.00	520.50	0.00	456.00	456.00	8041.93	4.00	488.00	447.25
0.7	0.4	0.1	2	3764289.75	0.46	0.00	498.50	0.00	498.50	498.50	9583.73	54.00	520.50	4.25	520.50	516.25	9015.72	17.50	488.00	488.00
0.7	0.5	0.005	0	8688294.50	0.98	23605.25	10017.75	9080.00	10017.75	937.75	4272.78	52651.25	9950.75	7877.50	9950.75	2073.25	16278.09	262177.25	9951.00	9951.00
0.7	0.5	0.005	1	6161089.50	0.95	0.00	10017.75	0.00	450.25	450.25	8384.83	0.00	9950.75	0.00	874.25	874.25	16200.70	1992.00	9951.00	1276.50
0.7	0.5	0.005	2	6067894.50	0.95	0.00	10017.75	0.00	412.75	412.75	7819.51	0.00	9950.75	0.00	620.00	620.00	12016.81	67881.00	9951.00	1914.75
0.7	0.5	0.01	0	8660182.75	0.97	10358.00	4933.25	3871.50	4933.25	1061.75	9029.16	22341.75	4954.50	3231.75	4954.50	1722.75	19422.19	185093.50	5047.75	5047.75
0.7	0.5	0.01	1	6155814.50	0.97	0.00	4933.25	0.00	473.00	473.00	8842.86	0.00	4954.50	0.00	810.25	810.25	14941.25	1629.75	5047.75	1220.75
0.7	0.5	0.01	2	5878555.50	0.96	0.00	4933.25	0.00	400.50	400.50	7361.64	0.00	4954.50	0.00	600.00	600.00	11162.57	66673.75	5047.75	1784.50
0.7	0.5	0.05	0	5328078.25	0.60	1084.25	1008.00	328.25	1008.00	679.75	10440.12	1447.00	987.00	178.00	987.00	809.00	13037.67	29291.50	999.50	999.50
0.7	0.5	0.05	1	4776705.75	0.97	0.00	1008.00	0.00	552.25	552.25	10423.51	4.00	987.00	0.00	607.00	607.00	11466.35	203.75	999.50	669.50
0.7	0.5	0.05	2	6008762.25	0.88	144.25	1008.00	21.00	709.25	688.25	13342.44	51.75	987.00	0.50	714.00	713.50	13822.81	6069.75	999.50	920.25
0.7	0.5	0.1	0	3264678.75	0.37	218.50	499.00	55.25	499.00	443.75	7571.44	271.00	503.75	24.75	503.75	479.00	8839.22	7178.25	491.25	491.25
0.7	0.5	0.1	1	3247349.50	0.90	0.00	499.00	0.00	407.25	407.25	7559.14	0.00	503.75	0.00	434.75	434.75	8248.44	11.75	491.25	436.25
0.7	0.5	0.1	2	3762992.50	0.47	11.50	499.00	0.00	499.00	499.00	9155.75	97.00	503.75	6.00	503.75	497.75	9226.75	10.50	491.25	491.25
0.7	0.6	0.005	0	8650504.50	0.98	23618.75	9964.50	9068.75	9964.50	895.75	4698.13	52272.00	10003.00	7886.50	10003.00	2116.50	17118.27	255471.00	10014.50	10014.50
0.7	0.6	0.005	1	6200431.75	0.96	0.00	9964.50	0.00	436.25	436.25	8691.30	0.00	10003.00	0.00	851.75	851.75	15762.86	1846.00	10014.50	1284.50
0.7	0.6	0.005	2	6067606.50	0.95	0.00	9964.50	0.00	433.25	433.25	7945.75	5.25	10003.00	0.00	609.00	609.00	11189.32	66976.75	10014.50	1924.00
0.7	0.6	0.01	0	8625838.50	0.97	10572.75	4975.50	3939.75	4975.50	1035.75	10007.26	23067.00	5035.25	3347.75	5035.25	1687.50	19062.94	174421.50	5006.50	5006.50
0.7	0.6	0.01	1	6262172.75	0.97	0.00	4975.50	0.00	524.75	524.75	9928.38	0.00	5035.25	0.00	814.75	814.75	14626.03	1613.50	5006.50	1114.00
0.7	0.6	0.01	2	5937479.75	0.95	0.00	4975.50	0.00	412.25	412.25	8181.02	0.00	5035.25	0.00	591.00	591.00	10572.69	62370.75	5006.50	1719.50
0.7	0.6	0.05	0	4865683.75	0.55	1055.25	980.25	346.75	980.25	633.50	9619.03	1903.25	980.75	254.00	980.75	726.75	11796.40	25788.50	986.25	986.25
0.7	0.6	0.05	1	4354521.75	0.96	0.00	980.25	0.00	508.75	508.75	9246.88	11.75	980.75	0.25	564.75	564.50	10528.46	183.50	986.25	646.50
0.7	0.6	0.05	2	5808533.50	0.88	103.25	980.25	13.50	703.75	690.25	13318.58	105.00	980.75	1.00	690.00	689.00	13922.03	6052.00	986.25	905.25
0.7	0.6	0.1	0	3125436.50	0.36	350.00	492.25	91.00	492.25	401.25	5917.40	561.00	507.75	55.75	507.75	452.00	8177.37	12776.25	513.75	513.75
0.7	0.6	0.1	1	3086917.50	0.89	0.00	492.25	0.00	379.25	379.25	6322.91	0.25	507.75	0.00	408.00	408.00	7640.57	6.25	513.75	439.75
0.7	0.6	0.1	2	3748420.25	0.49	3.00	492.25	0.00	492.25	492.25	8272.64	208.75	507.75	11.75	507.50	495.75	9174.77	52.00	513.75	513.75

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF drops	EF ctotal	EF cfail	EF cacc	EF csuc	EF ssuc	AF drops	AF ctotal	AF cfail	AF cacc	AF csuc	AF ssuc	BE drops	BE ctotal	BE cacc
0.7	0.7	0.005	0	8673972.25	0.98	24320.75	10041.50	9139.50	10041.50	902.00	5320.35	52706.50	10004.50	7861.50	10004.50	2143.00	18997.48	241570.50	10012.50	10012.50
0.7	0.7	0.005	1	6162398.25	0.96	0.00	10041.50	0.00	440.25	440.25	7938.27	0.00	10004.50	0.00	867.25	867.25	16384.79	1866.75	10012.50	1262.50
0.7	0.7	0.005	2	6091465.75	0.95	0.00	10041.50	0.00	428.75	428.75	8045.43	0.00	10004.50	0.00	606.75	606.75	11336.44	64479.00	10012.50	1861.00
0.7	0.7	0.01	0	8465855.50	0.95	10906.00	4993.75	4022.50	4993.75	971.25	8922.04	22394.50	4980.00	3298.00	4980.00	1682.00	19903.44	153603.25	4980.50	4980.50
0.7	0.7	0.01	1	5983606.50	0.96	0.00	4993.75	0.00	508.25	508.25	9357.82	2.50	4980.00	0.25	782.00	781.75	14593.13	1165.75	4980.50	1085.00
0.7	0.7	0.01	2	5831674.75	0.95	0.00	4993.75	0.00	398.25	398.25	7198.35	0.00	4980.00	0.00	569.50	569.50	11004.59	59627.75	4980.50	1675.25
0.7	0.7	0.05	0	4439226.25	0.49	1209.50	1008.50	441.00	1008.50	567.50	8510.11	2334.00	991.50	317.75	991.50	673.75	10238.67	26930.00	993.25	993.25
0.7	0.7	0.05	1	4050527.75	0.94	0.00	1008.50	0.00	471.00	471.00	8507.08	6.25	991.50	0.00	536.00	536.00	9987.26	90.00	993.25	591.50
0.7	0.7	0.05	2	5453747.25	0.85	123.75	1008.50	26.25	643.75	617.50	11284.31	90.75	991.50	1.75	673.50	671.75	12961.82	9018.00	993.25	879.25
0.7	0.7	0.1	0	2734781.75	0.31	451.00	516.50	158.75	516.50	357.75	5495.68	662.75	487.50	74.75	487.50	412.75	6774.35	16936.00	500.75	500.75
0.7	0.7	0.1	1	2728303.25	0.86	0.00	516.50	0.00	345.25	345.25	6302.65	0.00	487.50	0.00	340.75	340.75	6229.33	9.25	500.75	378.25
0.7	0.7	0.1	2	3745667.75	0.51	96.50	516.50	21.75	515.25	493.50	9219.14	211.25	487.50	9.25	485.75	476.50	8632.58	44.75	500.75	500.75
0.7	0.8	0.005	0	8594001.25	0.97	24092.00	10040.50	9119.25	10040.50	921.25	6308.96	52458.75	9975.50	7812.00	9975.50	2163.50	21107.34	210822.00	10021.25	10021.25
0.7	0.8	0.005	1	6074139.50	0.96	0.00	10040.50	0.00	470.50	470.50	8836.58	0.00	9975.50	0.00	869.00	869.00	15715.51	1765.50	10021.25	1244.75
0.7	0.8	0.005	2	5902538.50	0.95	0.00	10040.50	0.00	414.50	414.50	7890.44	0.00	9975.50	0.00	578.00	578.00	10413.94	58516.25	10021.25	1707.50
0.7	0.8	0.01	0	7830941.00	0.88	10846.50	5002.75	4074.50	5002.75	928.25	9362.80	23253.75	4957.75	3402.00	4957.75	1555.75	19007.95	129329.00	4995.00	4995.00
0.7	0.8	0.01	1	5893624.50	0.97	0.00	5002.75	0.00	527.00	527.00	10093.27	2.25	4957.75	0.00	787.75	787.75	14870.56	1131.75	4995.00	1014.75
0.7	0.8	0.01	2	5671152.50	0.95	0.00	5002.75	0.00	404.25	404.25	7698.53	0.00	4957.75	0.00	567.25	567.25	10834.23	51156.25	4995.00	1590.25
0.7	0.8	0.05	0	3777603.75	0.43	1410.25	1007.50	500.25	1007.50	507.25	7098.14	2942.50	1002.75	407.00	1002.75	595.75	8833.19	28916.25	979.25	979.25
0.7	0.8	0.05	1	3467537.50	0.91	0.00	1007.50	0.00	410.75	410.75	7675.45	0.00	1002.75	0.00	451.50	451.50	8509.49	127.00	979.25	501.75
0.7	0.8	0.05	2	4811687.00	0.78	46.50	1007.50	4.25	524.50	520.25	9821.80	75.50	1002.75	2.75	561.75	559.00	10610.86	13269.25	979.25	798.50
0.7	0.8	0.1	0	2461798.50	0.28	592.25	503.00	182.00	503.00	321.00	4823.17	1035.50	513.50	113.00	513.50	400.50	6119.15	17916.25	488.00	488.00
0.7	0.8	0.1	1	2505928.00	0.84	0.00	503.00	0.00	294.75	294.75	5281.85	4.00	513.50	0.00	332.00	332.00	6127.47	27.25	488.00	337.75
0.7	0.8	0.1	2	3649659.50	0.53	107.25	503.00	16.00	495.50	479.50	8260.27	293.50	513.50	12.00	497.00	485.00	8822.34	320.00	488.00	486.25
0.7	0.9	0.005	0	7808582.00	0.88	24060.50	9969.25	9072.75	9969.25	896.50	8173.92	53009.50	10002.00	8021.00	10002.00	1981.00	20587.93	169063.50	10021.75	10021.75
0.7	0.9	0.005	1	5836365.50	0.97	0.00	9969.25	0.00	505.25	505.25	9352.17	0.00	10002.00	0.00	749.75	749.75	13549.65	1316.75	10021.75	1037.75
0.7	0.9	0.005	2	5701583.25	0.94	0.00	9969.25	0.00	452.50	452.50	8428.99	0.00	10002.00	0.00	589.75	589.75	10756.91	45583.50	10021.75	1548.75
0.7	0.9	0.01	0	6775696.00	0.76	11017.00	4965.00	4196.50	4965.00	768.50	9188.32	25472.75	5107.75	3788.00	5107.75	1319.75	15574.36	101325.00	4987.75	4987.75
0.7	0.9	0.01	1	5115890.50	0.95	0.00	4965.00	0.00	494.75	494.75	9140.42	0.00	5107.75	0.00	695.75	695.75	12588.43	627.00	4987.75	877.75
0.7	0.9	0.01	2	5515099.50	0.93	0.00	4965.00	0.00	442.50	442.50	8123.67	0.00	5107.75	0.00	579.25	579.25	10837.08	39378.00	4987.75	1344.00
0.7	0.9	0.05	0	3193884.50	0.36	1583.25	1003.75	588.25	1003.75	415.50	5622.63	3171.00	990.50	447.00	990.50	543.50	7392.75	31217.00	975.75	975.75
0.7	0.9	0.05	1	2907930.00	0.86	0.00	1003.75	0.00	347.50	347.50	6549.03	3.50	990.50	0.00	405.50	405.50	7074.52	107.25	975.75	429.00
0.7	0.9	0.05	2	4109257.00	0.70	39.00	1003.75	5.25	416.75	411.50	7742.14	4.75	990.50	0.00	485.50	485.50	8814.09	17725.75	975.75	737.50
0.7	0.9	0.1	0	2103809.00	0.24	616.00	492.75	222.75	492.75	270.00	3924.20	1338.25	521.00	165.00	521.00	356.00	5077.45	21387.00	508.00	508.00
0.7	0.9	0.1	1	2067863.75	0.79	0.00	492.75	0.00	233.75	233.75	4350.94	1.50	521.00	0.00	281.50	281.50	5127.14	19.25	508.00	305.50
0.7	0.9	0.1	2	3475674.00	0.54	114.75	492.75	19.50	455.00	435.50	8135.19	245.00	521.00	9.75	477.00	467.25	8702.12	1253.00	508.00	498.50
0.7	1.0	0.005	0	3399237.00	0.39	25790.25	10007.25	9699.25	10007.25	308.00	894.84	56390.25	10028.00	8650.00	10028.00	1378.00	10886.83	127485.00	9929.50	9929.50
0.7	1.0	0.005	1	2377560.00	0.74	0.00	10007.25	0.00	140.75	140.75	2785.72	0.00	10028.00	0.00	343.25	343.25	7029.13	878.00	9929.50	551.25
0.7	1.0	0.005	2	3064146.50	0.62	0.00	10007.25	0.00	212.50	212.50	4045.68	0.00	10028.00	0.00	314.25	314.25	6128.32	31046.25	9929.50	839.00
0.7	1.0	0.01	0	3388109.25	0.38	11976.25	4983.75	4617.00	4983.75	366.75	1915.83	27494.50	4994.75	4120.75	4994.75	874.00	7073.52	101546.25	4956.75	4956.75
0.7	1.0	0.01	1	2560647.50	0.75	0.00	4983.75	0.00	173.25	173.25	3304.01	0.00	4994.75	0.00	340.25	340.25	6116.37	629.50	4956.75	507.75
0.7	1.0	0.01	2	3090832.75	0.62	0.00	4983.75	0.00	216.00	216.00	4130.64	0.25	4994.75	0.00	298.00	298.00	5655.47	31941.25	4956.75	842.75
0.7	1.0	0.05	0	2567794.75	0.29	1874.50	1001.00	692.75	1001.00	308.25	3995.79	3802.75	1001.50	548.75	1001.50	452.75	5627.21	32017.00	977.25	977.25
0.7	1.0	0.05	1	2339957.25	0.80	0.00	1001.00	0.00	260.75	260.75	4834.05	2.50	1001.50	0.00	318.50	318.50	5844.97	124.00	977.25	364.25
0.7	1.0	0.05	2	3294278.25	0.61	5.00	1001.00	0.00	309.00	309.00	5746.59	16.75	1001.50	0.75	366.00	365.25	7027.99	20144.75	977.25	656.50
0.7	1.0	0.1	0	1841921.50	0.21	724.75	498.75	252.50	498.75	246.25	3032.10	1380.75	488.00	161.00	488.00	327.00	4698.96	22659.25	485.75	485.75
0.7	1.0	0.1	1	1822083.50	0.77	0.00	498.75	0.00	205.75	205.75	4075.37	0.25	488.00	0.00	237.00	237.00	4345.56	19.00	485.75	269.50
0.7	1.0	0.1	2	3206970.50	0.51	200.00	498.75	47.50	435.50	388.00	7228.89	161.00	488.00	5.50	426.50	421.00	7710.26	1793.25	485.75	472.50

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
0.8	0.3	0.005	0	8791548.25	0.97	23427.50	9997.50	9089.50	9997.50	908.00	6169.71	53191.00	10012.25	8059.50	10012.25	1952.75	17656.17	238803.25	9875.75	9875.75
0.8	0.3	0.005	1	5862583.75	0.96	0.00	9997.50	0.00	424.50	424.50	8138.89	0.00	10012.25	0.00	836.25	836.25	15730.94	1750.75	9875.75	1194.00
0.8	0.3	0.005	2	6036045.75	0.95	0.00	9997.50	0.00	402.75	402.75	7387.97	0.00	10012.25	0.00	591.25	591.25	11415.88	64750.50	9875.75	1858.00
0.8	0.3	0.01	0	8087325.00	0.89	10963.00	5030.00	4102.00	5030.00	928.00	8676.31	22794.50	4964.25	3412.25	4964.25	1552.00	16184.15	163847.50	5050.75	5050.75
0.8	0.3	0.01	1	5563656.00	0.96	0.00	5030.00	0.00	462.75	462.75	9029.08	0.25	4964.25	0.00	741.25	741.25	14383.39	1024.75	5050.75	1058.25
0.8	0.3	0.01	2	5841612.75	0.95	0.00	5030.00	0.00	399.25	399.25	7598.11	0.00	4964.25	0.00	576.50	576.50	11095.56	63615.25	5050.75	1737.50
0.8	0.3	0.05	0	5190014.00	0.58	1175.25	1015.75	336.00	1015.75	679.75	9625.52	1789.25	997.00	186.75	997.00	810.25	12594.91	39782.75	995.25	995.25
0.8	0.3	0.05	1	4765298.25	0.96	0.00	1015.75	0.00	541.50	541.50	9689.67	0.00	997.00	0.00	597.00	597.00	10989.36	197.50	995.25	675.75
0.8	0.3	0.05	2	5823275.75	0.85	144.75	1015.75	20.25	656.50	636.25	11921.08	22.25	997.00	0.00	691.00	691.00	13021.36	8316.00	995.25	903.50
0.8	0.3	0.1	0	3713890.50	0.40	61.75	498.00	15.25	498.00	482.75	9218.50	59.50	497.50	7.00	497.50	490.50	8405.30	319.50	495.00	495.00
0.8	0.3	0.1	1	3296278.00	0.91	0.00	498.00	0.00	410.25	410.25	8166.95	0.00	497.50	0.00	438.75	438.75	7712.58	0.75	495.00	453.00
0.8	0.3	0.1	2	3772602.25	0.45	0.00	498.00	0.00	498.00	498.00	9671.23	0.00	497.50	0.00	497.50	497.50	8584.95	19.25	495.00	495.00
0.8	0.4	0.005	0	8777497.50	0.98	23427.00	9957.00	9077.50	9957.00	879.50	5748.23	53245.75	9996.00	7980.25	9996.00	2015.75	17759.24	246853.50	10097.50	10097.50
0.8	0.4	0.005	1	6068543.00	0.96	0.00	9957.00	0.00	436.25	436.25	8584.99	0.00	9996.00	0.00	858.25	858.25	15158.66	1526.50	10097.50	1277.50
0.8	0.4	0.005	2	5988294.75	0.95	0.00	9957.00	0.00	410.50	410.50	7482.83	0.00	9996.00	0.00	581.75	581.75	10826.65	64977.00	10097.50	1912.75
0.8	0.4	0.01	0	8419881.75	0.92	10740.50	4976.00	4021.75	4976.00	954.25	9091.32	22799.25	4974.00	3371.75	4974.00	1602.25	17628.10	154642.75	4960.50	4960.50
0.8	0.4	0.01	1	5846800.25	0.97	0.00	4976.00	0.00	499.25	499.25	9634.43	0.00	4974.00	0.00	790.25	790.25	14582.43	1062.00	4960.50	1078.75
0.8	0.4	0.01	2	5947289.50	0.95	0.00	4976.00	0.00	406.75	406.75	7537.25	2.00	4974.00	0.00	584.00	584.00	11365.58	62198.75	4960.50	1722.75
0.8	0.4	0.05	0	5125724.50	0.57	1181.75	966.25	334.50	966.25	631.75	9150.36	1653.00	997.00	181.00	997.00	816.00	13391.22	35840.50	1010.25	1010.25
0.8	0.4	0.05	1	4646801.00	0.95	0.00	966.25	0.00	501.50	501.50	9318.59	5.75	997.00	0.25	591.25	591.00	11126.37	269.25	1010.25	685.25
0.8	0.4	0.05	2	5809226.50	0.85	86.75	966.25	5.25	646.25	641.00	11805.29	52.00	997.00	1.00	679.50	678.50	12938.91	8390.00	1010.25	903.25
0.8	0.4	0.1	0	3451889.00	0.38	188.00	514.25	55.00	514.25	459.25	7206.79	99.75	493.25	7.25	493.25	486.00	8955.19	5537.75	495.00	495.00
0.8	0.4	0.1	1	3284362.00	0.91	15.75	514.25	3.00	427.00	424.00	7329.94	0.00	493.25	0.00	428.25	428.25	8056.27	16.25	495.00	440.25
0.8	0.4	0.1	2	3743667.00	0.46	0.00	514.25	0.00	514.25	514.25	8900.06	23.75	493.25	0.25	493.25	493.00	9160.32	31.25	495.00	495.00
0.8	0.5	0.005	0	8794753.00	0.98	23766.25	10001.00	9091.00	10001.00	910.00	5914.93	52805.00	10014.00	7948.25	10014.00	2065.75	18688.35	243600.50	10074.25	10074.25
0.8	0.5	0.005	1	6108064.50	0.96	0.00	10001.00	0.00	438.50	438.50	8493.57	0.00	10014.00	0.00	865.00	865.00	16380.44	1959.75	10074.25	1291.75
0.8	0.5	0.005	2	5915832.50	0.95	0.00	10001.00	0.00	401.50	401.50	7417.08	0.00	10014.00	0.00	593.75	593.75	11231.02	63986.75	10074.25	1858.50
0.8	0.5	0.01	0	8585104.00	0.94	10814.25	5026.50	4040.75	5026.50	985.75	9905.48	22682.25	5013.00	3398.00	5013.00	1615.00	18062.99	149009.75	5019.25	5019.25
0.8	0.5	0.01	1	6136972.50	0.97	0.00	5026.50	0.00	491.25	491.25	9384.02	0.75	5013.00	0.00	779.75	779.75	14412.62	1108.25	5019.25	1077.50
0.8	0.5	0.01	2	5835028.25	0.95	0.00	5026.50	0.00	406.25	406.25	7902.08	1.25	5013.00	0.00	585.25	585.25	10809.08	64642.75	5019.25	1713.00
0.8	0.5	0.05	0	4893826.25	0.54	1094.25	1002.50	366.75	1002.50	635.75	9411.16	1596.25	977.25	208.00	977.25	769.25	12745.12	30626.75	1024.50	1024.50
0.8	0.5	0.05	1	4405160.50	0.95	0.00	1002.50	0.00	528.00	528.00	9999.92	0.00	977.25	0.00	569.25	569.25	10719.74	92.50	1024.50	656.25
0.8	0.5	0.05	2	5704411.00	0.86	113.00	1002.50	8.75	681.75	673.00	13032.31	32.50	977.25	0.25	686.00	685.75	13233.01	8693.50	1024.50	937.25
0.8	0.5	0.1	0	3251848.50	0.35	324.00	507.75	96.75	507.75	411.00	6578.40	537.25	516.50	47.00	516.50	469.50	8135.49	8952.00	504.00	504.00
0.8	0.5	0.1	1	3091289.00	0.89	0.00	507.75	0.00	390.25	390.25	7092.77	0.00	516.50	0.00	410.25	410.25	7408.39	20.00	504.00	426.75
0.8	0.5	0.1	2	3771649.25	0.47	4.00	507.75	0.00	507.75	507.75	9112.23	151.50	516.50	6.00	516.50	510.50	9276.62	17.50	504.00	504.00
0.8	0.6	0.005	0	8769732.25	0.98	23850.50	10051.25	9105.25	10051.25	946.00	6384.82	52761.50	9977.00	7904.00	9977.00	2073.00	18903.65	236254.25	9974.00	9974.00
0.8	0.6	0.005	1	6175805.75	0.96	0.00	10051.25	0.00	442.75	442.75	8416.68	0.00	9977.00	0.00	833.50	833.50	15148.84	1872.75	9974.00	1264.75
0.8	0.6	0.005	2	5900737.50	0.95	0.00	10051.25	0.00	395.25	395.25	7268.00	0.00	9977.00	0.00	587.25	587.25	10710.15	62956.25	9974.00	1837.50
0.8	0.6	0.01	0	8349560.50	0.91	10922.75	5105.25	4120.25	5105.25	985.00	9966.75	23127.75	4986.50	3406.25	4986.50	1580.25	17831.82	144560.25	4972.00	4972.00
0.8	0.6	0.01	1	5956163.00	0.97	0.00	5105.25	0.00	518.75	518.75	9958.67	0.00	4986.50	0.00	795.25	795.25	14838.33	925.50	4972.00	1092.50
0.8	0.6	0.01	2	5764991.50	0.95	0.00	5105.25	0.00	420.00	420.00	8067.42	0.00	4986.50	0.00	584.75	584.75	10679.17	58192.25	4972.00	1707.00
0.8	0.6	0.05	0	4594089.50	0.50	1131.50	990.50	409.00	990.50	581.50	8643.29	2105.00	981.75	283.00	981.75	698.75	11210.76	27584.75	1000.75	1000.75
0.8	0.6	0.05	1	4113040.75	0.94	0.00	990.50	0.00	483.75	483.75	8878.31	6.50	981.75	0.00	538.50	538.50	10245.57	142.25	1000.75	620.00
0.8	0.6	0.05	2	5540413.25	0.86	141.25	990.50	16.50	629.00	612.50	11835.53	111.75	981.75	3.00	659.00	656.00	13003.59	8039.75	1000.75	900.75
0.8	0.6	0.1	0	2805787.50	0.31	354.00	472.25	111.00	472.25	361.25	5737.85	743.25	493.50	81.75	493.50	411.75	6951.35	15762.25	501.50	501.50
0.8	0.6	0.1	1	2711094.50	0.86	0.00	472.25	0.00	324.50	324.50	5772.12	0.00	493.50	0.00	359.25	359.25	6435.14	6.50	501.50	395.25
0.8	0.6	0.1	2	3571951.75	0.49	40.25	472.25	14.00	472.25	458.25	8032.49	206.00	493.50	11.00	493.25	482.25	8662.75	54.50	501.50	501.50

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF drops	EF ctotal	EF cfail	EF cacc	EF csuc	EF ssuc	AF drops	AF ctotal	AF cfail	AF cacc	AF csuc	AF ssuc	BE drops	BE ctotal	BE cacc
0.8	0.7	0.005	0	8758990.75	0.97	24181.25	10012.50	9084.25	10012.50	928.25	6894.16	51981.50	9959.50	7835.75	9959.50	2123.75	20399.35	222358.75	10059.25	10059.25
0.8	0.7	0.005	1	6009202.25	0.96	0.00	10012.50	0.00	437.50	437.50	8234.38	0.00	9959.50	0.00	838.50	838.50	15853.12	1920.75	10059.25	1231.25
0.8	0.7	0.005	2	5837668.25	0.95	0.00	10012.50	0.00	388.50	388.50	7000.95	0.00	9959.50	0.00	580.75	580.75	11509.31	63582.75	10059.25	1785.00
0.8	0.7	0.01	0	8105592.50	0.89	10314.75	4935.75	3931.25	4935.75	1004.50	10739.08	23050.75	4936.00	3382.75	4936.00	1553.25	18869.94	138174.00	5029.50	5029.50
0.8	0.7	0.01	1	5793957.00	0.97	0.00	4935.75	0.00	496.25	496.25	9475.17	0.00	4936.00	0.00	773.50	773.50	14357.05	1249.25	5029.50	1046.75
0.8	0.7	0.01	2	5570219.25	0.95	0.00	4935.75	0.00	419.50	419.50	7534.08	0.00	4936.00	0.00	563.00	563.00	10277.68	54529.25	5029.50	1640.75
0.8	0.7	0.05	0	4095930.25	0.45	1371.50	1007.75	498.00	1007.75	509.75	7503.46	2680.75	1007.00	367.75	1007.00	639.25	9597.72	28067.50	1005.50	1005.50
0.8	0.7	0.05	1	3648279.00	0.92	0.00	1007.75	0.00	441.25	441.25	8043.90	20.50	1007.00	0.50	483.25	482.75	9014.95	139.00	1005.50	523.25
0.8	0.7	0.05	2	5256364.50	0.84	111.00	1007.75	34.25	608.50	574.25	10171.75	33.50	1007.00	0.00	654.00	654.00	12284.13	8225.00	1005.50	878.50
0.8	0.7	0.1	0	2709800.00	0.30	534.50	516.50	180.50	516.50	336.00	5409.97	763.25	484.00	84.50	484.00	399.50	6559.17	19645.50	511.00	511.00
0.8	0.7	0.1	1	2637040.25	0.85	0.00	516.50	0.00	314.50	314.50	6142.79	0.00	484.00	0.00	320.75	320.75	5918.50	14.75	511.00	358.75
0.8	0.7	0.1	2	3694556.00	0.51	119.00	516.50	31.75	516.50	484.75	8551.44	222.50	484.00	8.50	483.75	475.25	8657.89	75.25	511.00	511.00
0.8	0.8	0.005	0	8486755.75	0.93	24544.75	10095.75	9134.25	10095.75	961.50	8413.34	52428.00	9998.25	7875.25	9998.25	2123.00	21017.96	192733.00	10024.75	10024.75
0.8	0.8	0.005	1	5928265.00	0.96	0.00	10095.75	0.00	490.75	490.75	9636.91	0.25	9998.25	0.00	836.25	836.25	15811.38	1952.25	10024.75	1173.75
0.8	0.8	0.005	2	5694473.75	0.95	0.00	10095.75	0.00	411.75	411.75	7880.69	0.00	9998.25	0.00	582.25	582.25	11067.02	59142.75	10024.75	1691.75
0.8	0.8	0.01	0	7500836.50	0.83	10835.00	5019.50	4110.25	5019.50	909.25	9909.74	24054.00	5020.50	3549.00	5020.50	1471.50	17922.54	130476.00	5062.50	5062.50
0.8	0.8	0.01	1	5633932.50	0.97	0.00	5019.50	0.00	501.75	501.75	9492.59	0.00	5020.50	0.00	752.50	752.50	14475.33	1046.50	5062.50	971.00
0.8	0.8	0.01	2	5587333.25	0.95	0.00	5019.50	0.00	428.00	428.00	8028.77	0.00	5020.50	0.00	561.50	561.50	10531.39	52106.00	5062.50	1528.00
0.8	0.8	0.05	0	3412866.00	0.37	1471.25	1025.00	568.50	1025.00	456.50	6428.42	3148.25	1019.50	455.75	1019.50	563.75	7823.78	29963.75	1004.25	1004.25
0.8	0.8	0.05	1	3161188.50	0.90	0.00	1025.00	0.00	386.75	386.75	7334.49	5.50	1019.50	0.00	426.75	426.75	7845.17	82.25	1004.25	451.00
0.8	0.8	0.05	2	4812482.00	0.78	66.25	1025.00	9.00	543.75	534.75	10401.44	135.00	1019.50	2.00	576.75	574.75	11011.33	11917.00	1004.25	816.75
0.8	0.8	0.1	0	2247756.00	0.25	602.00	517.75	217.50	517.75	300.25	3934.92	1109.75	488.50	131.25	488.50	357.25	5695.49	20807.25	505.25	505.25
0.8	0.8	0.1	1	2245432.00	0.80	0.00	517.75	0.00	268.50	268.50	4623.84	0.00	488.50	0.00	280.50	280.50	5093.01	13.50	505.25	315.50
0.8	0.8	0.1	2	3607745.50	0.52	148.50	517.75	34.75	512.00	477.25	8157.20	294.75	488.50	13.25	480.00	466.75	8436.98	296.00	505.25	505.00
0.8	0.9	0.005	0	7553260.00	0.84	24388.25	9978.75	9102.25	9978.75	876.50	8572.39	52245.75	9925.75	7868.00	9925.75	2057.75	22163.27	166628.25	10025.25	10025.25
0.8	0.9	0.005	1	5398191.00	0.95	0.00	9978.75	0.00	482.50	482.50	9260.38	0.00	9925.75	0.00	710.00	710.00	13058.94	1101.25	10025.25	960.25
0.8	0.9	0.005	2	5652215.75	0.94	0.00	9978.75	0.00	438.00	438.00	8039.46	0.25	9925.75	0.00	589.75	589.75	10892.25	46976.50	10025.25	1557.75
0.8	0.9	0.01	0	6685816.00	0.74	10909.50	5009.25	4263.00	5009.25	746.25	9609.22	24480.75	5006.75	3713.00	5006.75	1293.75	16249.58	94048.00	5068.00	5068.00
0.8	0.9	0.01	1	5087400.00	0.96	0.00	5009.25	0.00	489.75	489.75	9172.82	4.75	5006.75	0.00	704.25	704.25	13166.09	517.25	5068.00	890.25
0.8	0.9	0.01	2	5296536.00	0.93	0.00	5009.25	0.00	440.25	440.25	8351.43	2.00	5006.75	0.00	571.50	571.50	10452.85	39272.75	5068.00	1329.00
0.8	0.9	0.05	0	2793100.00	0.30	1700.75	1030.00	673.50	1030.00	356.50	4463.82	3581.25	977.00	521.00	977.00	456.00	5563.96	32935.00	985.00	985.00
0.8	0.9	0.05	1	2654323.50	0.85	0.00	1030.00	0.00	307.75	307.75	5418.80	0.00	977.00	0.00	328.00	328.00	5837.52	85.00	985.00	377.50
0.8	0.9	0.05	2	4053479.50	0.70	58.25	1030.00	4.50	421.00	416.50	7615.78	31.50	977.00	1.00	445.50	444.50	8518.83	16677.00	985.00	724.25
0.8	0.9	0.1	0	1934080.25	0.21	674.75	506.00	242.75	506.00	263.25	3357.88	1230.50	491.00	150.50	491.00	340.50	5078.80	23167.75	512.75	512.75
0.8	0.9	0.1	1	1806468.25	0.76	0.00	506.00	0.00	213.00	213.00	4005.09	0.00	491.00	0.00	235.00	235.00	4282.06	39.50	512.75	280.50
0.8	0.9	0.1	2	3459194.25	0.54	152.25	506.00	32.00	480.25	448.25	8291.78	236.00	491.00	11.50	464.25	452.75	8066.23	854.25	512.75	505.50
0.8	1.0	0.005	0	3383284.75	0.38	25648.25	9946.25	9634.50	9946.25	311.75	1398.45	55092.25	9960.25	8445.50	9960.25	1514.75	13160.49	118878.25	10056.25	10056.25
0.8	1.0	0.005	1	2298261.00	0.73	0.00	9946.25	0.00	143.50	143.50	2502.87	0.00	9960.25	0.00	340.75	340.75	6629.30	570.75	10056.25	524.00
0.8	1.0	0.005	2	3030046.50	0.61	0.00	9946.25	0.00	219.50	219.50	4030.53	0.00	9960.25	0.00	339.50	339.50	6066.69	30445.25	10056.25	801.00
0.8	1.0	0.01	0	3405889.75	0.38	11873.50	4995.00	4633.00	4995.00	362.00	2725.31	27236.50	4996.75	4094.50	4996.75	902.25	8725.53	89927.00	5027.25	5027.25
0.8	1.0	0.01	1	2572869.25	0.78	0.00	4995.00	0.00	196.50	196.50	3594.83	0.00	4996.75	0.00	359.00	359.00	6921.03	506.00	5027.25	519.00
0.8	1.0	0.01	2	3121258.25	0.61	0.00	4995.00	0.00	229.75	229.75	4659.28	0.00	4996.75	0.00	321.25	321.25	5446.65	32433.50	5027.25	813.50
0.8	1.0	0.05	0	2084633.50	0.23	2055.75	1031.00	765.25	1031.00	265.75	3062.16	4493.00	1008.25	646.75	1008.25	361.50	4172.85	34057.50	999.00	999.00
0.8	1.0	0.05	1	1897687.50	0.78	0.00	1031.00	0.00	216.50	216.50	4163.21	0.00	1008.25	0.00	240.25	240.25	4602.08	53.00	999.00	298.25
0.8	1.0	0.05	2	3321393.75	0.61	0.00	1031.00	0.00	292.75	292.75	5456.50	0.50	1008.25	0.00	351.50	351.50	6907.57	21087.50	999.00	653.75
0.8	1.0	0.1	0	1634648.75	0.18	903.25	508.00	293.50	508.00	214.50	2397.76	1572.75	494.75	203.75	494.75	291.00	3573.65	23378.25	489.75	489.75
0.8	1.0	0.1	1	1617879.75	0.74	0.00	508.00	0.00	183.00	183.00	3576.47	0.25	494.75	0.00	199.00	199.00	3942.69	22.50	489.75	234.00
0.8	1.0	0.1	2	3113140.50	0.51	242.75	508.00	67.25	450.50	383.25	6821.44	194.00	494.75	5.25	430.50	425.25	8560.20	1537.25	489.75	478.75

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF drops	EF ctotal	EF cfail	EF cacc	EF csuc	EF ssuc	AF drops	AF ctotal	AF cfail	AF cacc	AF csuc	AF ssuc	BE drops	BE ctotal	BE cacc
0.9	0.3	0.005	0	8227824.50	0.89	23778.50	9993.00	9185.50	9993.00	807.50	7997.84	54206.75	9951.00	8235.00	9951.00	1716.00	15952.61	201809.50	10004.00	10004.00
0.9	0.3	0.005	1	5574779.75	0.96	0.00	9993.00	0.00	439.50	439.50	8476.19	0.00	9951.00	0.00	772.50	772.50	14666.01	1117.00	10004.00	1133.00
0.9	0.3	0.005	2	5779867.25	0.94	0.00	9993.00	0.00	418.50	418.50	7798.77	0.00	9951.00	0.00	575.75	575.75	10520.75	56849.75	10004.00	1720.75
0.9	0.3	0.01	0	6908237.50	0.74	11275.75	5008.50	4256.25	5008.50	752.25	7160.54	23946.50	4969.50	3603.25	4969.50	1366.25	12806.03	147171.00	5017.25	5017.25
0.9	0.3	0.01	1	5300446.75	0.97	0.00	5008.50	0.00	443.50	443.50	8213.62	2.00	4969.50	0.00	719.00	719.00	14351.62	648.00	5017.25	985.50
0.9	0.3	0.01	2	5710243.25	0.95	0.00	5008.50	0.00	416.00	416.00	7518.73	0.00	4969.50	0.00	532.25	532.25	9765.16	55346.50	5017.25	1597.25
0.9	0.3	0.05	0	4938700.25	0.54	1272.25	995.25	371.75	995.25	623.50	8288.44	1960.00	1021.50	182.00	1021.50	839.50	13118.22	50876.25	1041.50	1041.50
0.9	0.3	0.05	1	4319760.50	0.93	0.00	995.25	0.00	427.75	427.75	7903.73	0.00	1021.50	0.00	546.25	546.25	10087.11	337.75	1041.50	629.50
0.9	0.3	0.05	2	5258834.50	0.80	46.75	995.25	3.25	542.25	539.00	10494.82	4.75	1021.50	0.00	608.25	608.25	10988.89	13218.00	1041.50	866.00
0.9	0.3	0.1	0	3628455.50	0.38	135.25	500.75	30.75	500.75	470.00	8301.38	35.50	493.00	2.00	493.00	491.00	9192.62	1186.25	495.25	495.25
0.9	0.3	0.1	1	3179238.00	0.89	0.00	500.75	0.00	401.50	401.50	7161.59	0.00	493.00	0.00	418.25	418.25	7910.40	4.75	495.25	436.50
0.9	0.3	0.1	2	3730212.50	0.45	0.00	500.75	0.00	500.50	500.50	8993.73	0.75	493.00	0.00	493.00	493.00	9192.62	24.00	495.25	495.25
0.9	0.4	0.005	0	8518626.25	0.92	23697.50	10055.25	9216.75	10055.25	838.50	8226.52	53551.00	9977.75	8180.50	9977.75	1797.25	17740.31	192501.75	9979.75	9979.75
0.9	0.4	0.005	1	5686892.25	0.97	0.00	10055.25	0.00	451.50	451.50	8887.30	0.00	9977.75	0.00	774.00	774.00	14833.12	1266.25	9979.75	1133.25
0.9	0.4	0.005	2	5794496.50	0.94	0.00	10055.25	0.00	377.50	377.50	7023.42	0.00	9977.75	0.00	585.25	585.25	11108.61	57182.75	9979.75	1682.00
0.9	0.4	0.01	0	6847341.00	0.74	11055.50	5008.75	4261.50	5008.75	747.25	7283.16	23715.75	4911.75	3573.25	4911.75	1338.50	12662.94	144508.00	4952.00	4952.00
0.9	0.4	0.01	1	5259746.75	0.96	0.00	5008.75	0.00	466.50	466.50	8713.25	2.50	4911.75	0.00	713.25	713.25	13096.73	791.00	4952.00	929.00
0.9	0.4	0.01	2	5565406.75	0.94	0.00	5008.75	0.00	405.75	405.75	7774.49	0.00	4911.75	0.00	569.00	569.00	10780.70	59207.00	4952.00	1639.25
0.9	0.4	0.05	0	4838647.50	0.53	1403.00	1005.50	405.75	1005.50	599.75	8123.94	1976.00	986.75	232.25	986.75	754.50	12303.46	42131.25	1025.50	1025.50
0.9	0.4	0.05	1	4274459.25	0.92	0.00	1005.50	0.00	454.50	454.50	8725.37	0.25	986.75	0.00	513.00	513.00	9500.65	291.00	1025.50	634.00
0.9	0.4	0.05	2	5224372.50	0.80	115.00	1005.50	17.00	560.00	543.00	10699.48	1.50	986.75	0.00	598.75	598.75	11080.42	13068.25	1025.50	871.00
0.9	0.4	0.1	0	3543055.25	0.37	191.00	503.25	48.00	503.25	455.25	7501.59	200.00	509.00	21.00	509.00	488.00	9245.87	7252.50	499.00	499.00
0.9	0.4	0.1	1	3190155.75	0.89	0.00	503.25	0.00	391.75	391.75	7249.04	0.00	509.00	0.00	419.00	419.00	8090.84	40.75	499.00	428.25
0.9	0.4	0.1	2	3839484.25	0.47	0.00	503.25	0.00	503.25	503.25	9088.30	34.25	509.00	1.50	508.75	507.25	9424.46	84.75	499.00	499.00
0.9	0.5	0.005	0	8642257.50	0.94	24044.75	10120.50	9238.00	10120.50	882.50	8311.34	52458.00	9918.75	8025.75	9918.75	1893.00	19110.68	185009.25	9981.25	9981.25
0.9	0.5	0.005	1	5779732.50	0.96	0.00	10120.50	0.00	464.00	464.00	8637.89	1.75	9918.75	0.00	763.00	763.00	14288.67	1035.25	9981.25	1139.50
0.9	0.5	0.005	2	5743445.00	0.94	0.00	10120.50	0.00	410.25	410.25	7876.62	0.00	9918.75	0.00	570.00	570.00	10413.62	56825.75	9981.25	1741.50
0.9	0.5	0.01	0	6850926.50	0.74	11059.50	5012.75	4214.75	5012.75	798.00	7745.41	24140.75	4978.75	3608.25	4978.75	1370.50	13955.87	137474.00	4978.00	4978.00
0.9	0.5	0.01	1	5114324.25	0.96	0.00	5012.75	0.00	452.50	452.50	8482.13	0.00	4978.75	0.00	702.00	702.00	13271.93	650.50	4978.00	932.75
0.9	0.5	0.01	2	5609057.50	0.94	0.00	5012.75	0.00	418.25	418.25	8046.78	0.00	4978.75	0.00	554.75	554.75	10511.38	52846.50	4978.00	1598.25
0.9	0.5	0.05	0	4595127.00	0.50	1222.00	983.50	417.00	983.50	566.50	7761.43	2204.00	1013.75	273.25	1013.75	740.50	11161.91	32449.25	994.75	994.75
0.9	0.5	0.05	1	3868492.50	0.91	0.00	983.50	0.00	421.75	421.75	7905.33	0.00	1013.75	0.00	515.25	515.25	9373.05	148.75	994.75	582.75
0.9	0.5	0.05	2	5189053.50	0.80	53.50	983.50	3.50	545.00	541.50	10569.49	15.25	1013.75	0.00	592.50	592.50	10666.35	11827.25	994.75	835.75
0.9	0.5	0.1	0	3140423.00	0.33	351.50	508.25	86.00	508.25	422.25	7074.15	513.50	500.25	55.00	500.25	445.25	7608.44	10855.75	497.75	497.75
0.9	0.5	0.1	1	2894293.50	0.87	0.00	508.25	0.00	347.75	347.75	6940.90	0.00	500.25	0.00	374.25	374.25	7116.06	18.75	497.75	397.25
0.9	0.5	0.1	2	3785014.50	0.48	29.25	508.25	4.50	506.25	501.75	9678.84	163.00	500.25	9.75	499.50	489.75	8951.67	92.75	497.75	497.75
0.9	0.6	0.005	0	8541443.75	0.92	23656.25	9973.00	9078.25	9973.00	894.75	8789.85	53025.00	10015.00	8055.25	10015.00	1959.75	19345.95	178927.00	10040.50	10040.50
0.9	0.6	0.005	1	5784539.25	0.97	0.00	9973.00	0.00	474.75	474.75	8868.09	0.00	10015.00	0.00	806.75	806.75	15156.13	1157.00	10040.50	1119.00
0.9	0.6	0.005	2	5717845.75	0.95	0.00	9973.00	0.00	405.75	405.75	7396.49	0.00	10015.00	0.00	556.25	556.25	10323.68	56907.00	10040.50	1676.75
0.9	0.6	0.01	0	6979291.25	0.75	10992.50	5009.25	4159.25	5009.25	850.00	8284.40	24625.50	5025.50	3651.25	5025.50	1374.25	14347.39	130966.50	5046.00	5046.00
0.9	0.6	0.01	1	5394851.00	0.97	0.00	5009.25	0.00	494.00	494.00	9211.97	0.00	5025.50	0.00	735.75	735.75	14598.56	645.00	5046.00	937.25
0.9	0.6	0.01	2	5567514.75	0.95	0.00	5009.25	0.00	403.50	403.50	7674.77	0.00	5025.50	0.00	550.50	550.50	11171.34	53045.00	5046.00	1565.75
0.9	0.6	0.05	0	4355109.25	0.47	1253.25	999.75	432.25	999.75	567.50	8206.45	2254.00	1006.25	311.75	1006.25	694.50	10224.73	27950.00	983.00	983.00
0.9	0.6	0.05	1	3722087.75	0.91	0.00	999.75	0.00	426.00	426.00	7987.28	3.00	1006.25	0.00	484.50	484.50	8581.27	51.75	983.00	546.25
0.9	0.6	0.05	2	5137829.50	0.81	175.00	999.75	21.75	580.25	558.50	10047.62	117.25	1006.25	0.75	612.75	612.00	11579.39	10407.50	983.00	834.00
0.9	0.6	0.1	0	2715406.00	0.29	499.50	509.50	163.75	509.50	345.75	5583.32	781.75	506.75	85.50	506.75	421.25	6925.17	17583.50	505.00	505.00
0.9	0.6	0.1	1	2465380.00	0.83	0.00	509.50	0.00	292.00	292.00	5713.86	0.00	506.75	0.00	316.25	316.25	5833.89	20.75	505.00	347.25
0.9	0.6	0.1	2	3756867.50	0.52	43.00	509.50	9.75	508.25	498.50	9362.90	311.50	506.75	18.00	503.75	485.75	8771.59	146.25	505.00	504.25

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF drops	EF ctotal	EF cfail	EF cacc	EF csuc	EF ssuc	AF drops	AF ctotal	AF cfail	AF cacc	AF csuc	AF ssuc	BE drops	BE ctotal	BE cacc
0.9	0.7	0.005	0	8113928.00	0.88	23781.00	9982.50	9118.50	9982.50	864.00	8279.46	52075.75	9940.25	7908.50	9940.25	2031.75	20094.25	182690.00	9954.25	9954.25
0.9	0.7	0.005	1	5619331.00	0.96	0.00	9982.50	0.00	454.75	454.75	8466.42	8.75	9940.25	0.25	747.75	747.50	13559.84	1025.00	9954.25	1040.25
0.9	0.7	0.005	2	5577625.50	0.94	0.00	9982.50	0.00	396.00	396.00	7314.23	0.00	9940.25	0.00	558.50	558.50	9884.80	56167.75	9954.25	1685.50
0.9	0.7	0.01	0	6917278.25	0.74	10806.25	5022.25	4192.25	5022.25	830.00	9056.03	24478.50	4994.50	3665.50	4994.50	1329.00	14959.06	121912.25	5021.25	5021.25
0.9	0.7	0.01	1	5462649.25	0.97	0.00	5022.25	0.00	489.00	489.00	9191.98	0.00	4994.50	0.00	708.00	708.00	13386.10	655.25	5021.25	900.75
0.9	0.7	0.01	2	5446320.50	0.94	0.00	5022.25	0.00	400.75	400.75	7614.76	0.00	4994.50	0.00	537.00	537.00	9816.97	50241.00	5021.25	1521.25
0.9	0.7	0.05	0	3725512.50	0.39	1412.75	1015.25	534.25	1015.25	481.00	6629.49	2874.50	988.00	399.00	988.00	589.00	8103.23	29062.50	992.00	992.00
0.9	0.7	0.05	1	3209626.75	0.89	0.00	1015.25	0.00	376.00	376.00	6779.30	0.50	988.00	0.00	429.25	429.25	7698.81	91.25	992.00	466.00
0.9	0.7	0.05	2	5044226.00	0.81	40.25	1015.25	12.75	568.25	555.50	10445.52	88.00	988.00	0.75	583.25	582.50	10476.20	10912.25	992.00	842.50
0.9	0.7	0.1	0	2494464.75	0.26	529.00	499.00	187.75	499.00	311.25	4752.53	1192.75	513.25	126.50	513.25	386.75	6172.52	18967.50	493.00	493.00
0.9	0.7	0.1	1	2341324.50	0.82	0.00	499.00	0.00	268.00	268.00	4970.43	0.00	513.25	0.00	308.00	308.00	5713.05	20.00	493.00	311.00
0.9	0.7	0.1	2	3687941.25	0.52	112.50	499.00	22.25	497.75	475.50	8516.11	322.75	513.25	15.75	509.75	494.00	8706.36	116.50	493.00	493.00
0.9	0.8	0.005	0	7686770.25	0.84	24542.00	10024.50	9145.25	10024.50	879.25	7906.58	52602.00	9966.00	7943.25	9966.00	2022.75	20885.80	177622.00	9994.25	9994.25
0.9	0.8	0.005	1	5493612.75	0.96	0.00	10024.50	0.00	460.00	460.00	8447.54	0.00	9966.00	0.00	758.75	758.75	13945.68	997.75	9994.25	1049.75
0.9	0.8	0.005	2	5593518.00	0.94	0.00	10024.50	0.00	428.00	428.00	8008.74	0.00	9966.00	0.00	561.75	561.75	10087.50	52296.00	9994.25	1572.75
0.9	0.8	0.01	0	6737646.75	0.73	11022.75	5008.75	4250.25	5008.75	758.50	9378.26	24931.75	5041.00	3712.75	5041.00	1328.25	16401.09	102896.75	4961.00	4961.00
0.9	0.8	0.01	1	5359081.50	0.97	31.75	5008.75	1.00	535.75	534.75	10301.76	5.50	5041.00	0.25	743.75	743.50	14087.94	700.00	4961.00	913.25
0.9	0.8	0.01	2	5313471.75	0.94	19.00	5008.75	2.50	414.25	411.75	7844.10	0.00	5041.00	0.00	590.50	590.50	11110.62	43973.00	4961.00	1445.00
0.9	0.8	0.05	0	2993604.75	0.32	1612.75	1009.00	622.50	1009.00	386.50	5081.85	3228.50	976.00	465.00	976.00	511.00	6681.86	31172.75	999.75	999.75
0.9	0.8	0.05	1	2669795.00	0.85	0.00	1009.00	0.00	316.25	316.25	5694.85	0.00	976.00	0.00	340.50	340.50	6366.83	49.50	999.75	400.25
0.9	0.8	0.05	2	4699095.25	0.78	40.25	1009.00	9.50	516.00	506.50	9244.17	17.00	976.00	0.50	530.75	530.25	9673.39	12441.75	999.75	797.75
0.9	0.8	0.1	0	2037276.25	0.22	687.00	498.25	217.00	498.25	281.25	3480.80	1206.50	500.75	149.00	500.75	351.75	5008.10	22199.75	503.50	503.50
0.9	0.8	0.1	1	1976468.00	0.78	0.00	498.25	0.00	225.75	225.75	3887.28	0.00	500.75	0.00	262.25	262.25	4565.22	29.75	503.50	295.25
0.9	0.8	0.1	2	3475936.00	0.53	118.00	498.25	29.75	490.50	460.75	7939.06	368.00	500.75	16.25	489.75	473.50	7941.58	300.50	503.50	501.00
0.9	0.9	0.005	0	7106368.75	0.78	25441.00	10034.50	9232.75	10034.50	801.75	8186.30	52583.25	9997.50	7937.75	9997.50	2059.75	23346.94	148950.50	9964.75	9964.75
0.9	0.9	0.005	1	5340391.50	0.95	0.00	10034.50	0.00	481.25	481.25	9221.35	0.00	9997.50	0.00	691.75	691.75	12874.62	886.75	9964.75	924.25
0.9	0.9	0.005	2	5376194.50	0.94	0.00	10034.50	0.00	433.50	433.50	8270.23	0.00	9997.50	0.00	559.25	559.25	10315.81	45032.50	9964.75	1441.50
0.9	0.9	0.01	0	6369016.00	0.68	10759.50	4934.75	4199.25	4934.75	735.50	10654.59	25049.75	5007.50	3812.75	5007.50	1194.75	16549.47	57288.75	5020.75	5020.75
0.9	0.9	0.01	1	5155750.75	0.96	0.00	4934.75	0.00	550.75	550.75	10767.15	0.00	5007.50	0.00	667.75	667.75	13352.87	348.25	5020.75	799.00
0.9	0.9	0.01	2	5087712.50	0.92	24.50	4934.75	7.00	430.25	423.25	7914.02	0.00	5007.50	0.00	550.75	550.75	10471.81	39383.75	5020.75	1303.25
0.9	0.9	0.05	0	2335720.75	0.25	1976.00	1006.50	725.00	1006.50	281.50	3632.63	3985.00	975.00	583.00	975.00	392.00	4821.62	33323.25	1017.00	1017.00
0.9	0.9	0.05	1	2144213.25	0.80	0.00	1006.50	0.00	239.00	239.00	4565.81	0.00	975.00	0.00	265.00	265.00	5018.16	70.25	1017.00	331.00
0.9	0.9	0.05	2	4100226.75	0.70	43.00	1006.50	13.00	422.25	409.25	7844.05	7.50	975.00	0.00	427.25	427.25	8322.48	16552.75	1017.00	754.00
0.9	0.9	0.1	0	1687317.75	0.19	915.50	513.25	321.50	513.25	191.75	2247.38	1520.25	495.00	192.00	495.00	303.00	3856.21	24417.00	505.50	505.50
0.9	0.9	0.1	1	1568605.75	0.72	0.00	513.25	0.00	161.50	161.50	2995.82	0.00	495.00	0.00	188.00	188.00	3468.15	21.50	505.50	240.25
0.9	0.9	0.1	2	3402002.25	0.55	202.50	513.25	46.75	477.50	430.75	7619.71	219.50	495.00	9.75	460.75	451.00	8273.17	886.75	505.50	497.00
0.9	1.0	0.005	0	3383286.50	0.37	26574.25	10010.00	9674.25	10010.00	335.75	2537.94	55752.50	10117.50	8532.50	10117.50	1585.00	16230.40	100863.50	10005.50	10005.50
0.9	1.0	0.005	1	2594945.75	0.79	0.00	10010.00	0.00	206.75	206.75	3700.02	18.50	10117.50	1.25	336.00	334.75	5944.13	938.50	10005.50	445.50
0.9	1.0	0.005	2	3005428.25	0.60	0.00	10010.00	0.00	214.25	214.25	4183.39	1.25	10117.50	0.00	325.25	325.25	6066.47	30851.00	10005.50	841.25
0.9	1.0	0.01	0	3279104.25	0.35	12024.75	4992.00	4659.50	4992.00	332.50	4034.41	27180.00	4990.00	4199.25	4990.00	790.75	9248.22	62308.75	4973.50	4973.50
0.9	1.0	0.01	1	2669944.75	0.80	0.00	4992.00	0.00	235.50	235.50	4632.82	0.00	4990.00	0.00	358.75	358.75	6858.17	371.50	4973.50	462.50
0.9	1.0	0.01	2	3054170.00	0.61	0.00	4992.00	0.00	212.00	212.00	3869.71	4.50	4990.00	0.50	321.00	320.50	6254.56	33048.75	4973.50	856.50
0.9	1.0	0.05	0	1661840.00	0.18	2206.50	992.25	802.25	992.25	190.00	1696.37	4675.00	1006.50	691.25	1006.50	315.25	3107.58	33910.25	984.25	984.25
0.9	1.0	0.05	1	1461098.25	0.73	0.00	992.25	0.00	148.75	148.75	2797.45	0.00	1006.50	0.00	191.50	191.50	3690.39	67.50	984.25	229.00
0.9	1.0	0.05	2	3299365.00	0.60	23.50	992.25	1.75	299.75	298.00	5719.19	92.25	1006.50	2.00	362.75	360.75	6505.32	19272.75	984.25	630.00
0.9	1.0	0.1	0	1339825.75	0.15	954.50	510.00	351.50	510.00	158.50	1475.36	1745.75	487.50	222.25	487.50	265.25	3194.64	24674.00	503.75	503.75
0.9	1.0	0.1	1	1125698.00	0.68	0.00	510.00	0.00	117.50	117.50	2262.16	0.00	487.50	0.00	148.00	148.00	2769.04	13.50	503.75	188.75
0.9	1.0	0.1	2	3079188.00	0.52	266.25	510.00	68.75	442.25	373.50	7105.84	279.50	487.50	12.00	421.25	409.25	7710.59	2176.50	503.75	489.00

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
1.0	0.3	0.005	0	4544825.25	0.49	24674.50	9979.50	9640.50	9979.50	339.00	463.57	57209.50	9985.00	8775.25	9985.00	1209.75	6253.77	182551.25	10041.50	10041.50
1.0	0.3	0.005	1	2842587.75	0.78	0.00	9979.50	0.00	137.50	137.50	2612.68	0.00	9985.00	0.00	457.00	457.00	8541.21	363.00	10041.50	764.50
1.0	0.3	0.005	2	4144126.00	0.76	0.00	9979.50	0.00	310.00	310.00	6103.18	3.75	9985.00	0.00	412.00	412.00	7912.44	39374.25	10041.50	1110.00
1.0	0.3	0.01	0	4482974.25	0.49	11944.25	5020.75	4593.50	5020.75	427.25	1176.69	26357.50	5010.25	3934.50	5010.25	1075.75	6637.53	150165.50	5022.75	5022.75
1.0	0.3	0.01	1	2974677.50	0.78	0.00	5020.75	0.00	175.00	175.00	3211.30	0.00	5010.25	0.00	434.75	434.75	8041.85	190.25	5022.75	699.25
1.0	0.3	0.01	2	4168718.75	0.76	0.00	5020.75	0.00	311.50	311.50	5935.01	0.00	5010.25	0.00	407.00	407.00	7449.23	45662.75	5022.75	1171.00
1.0	0.3	0.05	0	4432644.75	0.48	1418.25	1003.00	406.75	1003.00	596.25	7242.36	2305.00	1009.50	236.50	1009.50	773.00	11669.87	52954.00	1014.25	1014.25
1.0	0.3	0.05	1	3695918.50	0.86	0.00	1003.00	0.00	346.00	346.00	6722.93	0.25	1009.50	0.00	450.25	450.25	8717.12	247.25	1014.25	572.00
1.0	0.3	0.05	2	4490311.50	0.71	114.75	1003.00	8.00	449.50	441.50	8346.18	18.25	1009.50	1.00	524.00	523.00	9892.57	17427.50	1014.25	808.25
1.0	0.3	0.1	0	3641042.25	0.37	160.25	499.00	47.50	499.00	451.50	8372.31	5.75	493.25	0.00	493.25	493.25	8872.41	1010.50	477.00	477.00
1.0	0.3	0.1	1	3152010.50	0.88	0.00	499.00	0.00	389.00	389.00	7601.31	0.00	493.25	0.00	411.00	411.00	7513.34	28.25	477.00	416.25
1.0	0.3	0.1	2	3769522.25	0.46	45.75	499.00	8.25	496.50	488.25	9159.74	3.00	493.25	0.00	490.00	490.00	8854.89	182.00	477.00	476.50
1.0	0.4	0.005	0	4522862.25	0.49	24413.00	9987.25	9628.75	9987.25	358.50	542.89	57323.25	10057.50	8815.50	10057.50	1242.00	6629.27	180348.25	9915.50	9915.50
1.0	0.4	0.005	1	2863555.00	0.77	0.00	9987.25	0.00	164.50	164.50	3160.44	0.00	10057.50	0.00	419.50	419.50	7966.24	510.00	9915.50	694.50
1.0	0.4	0.005	2	4028816.75	0.77	0.00	9987.25	0.00	283.25	283.25	5137.02	0.00	10057.50	0.00	437.00	437.00	8170.74	41554.00	9915.50	1143.00
1.0	0.4	0.01	0	4499321.75	0.49	11823.50	5020.00	4550.50	5020.00	469.50	1504.62	26396.00	4988.50	3959.25	4988.50	1029.25	6591.91	147663.25	5043.75	5043.75
1.0	0.4	0.01	1	2978791.25	0.78	0.00	5020.00	0.00	171.50	171.50	2964.32	0.00	4988.50	0.00	454.75	454.75	8632.49	294.50	5043.75	728.25
1.0	0.4	0.01	2	4105890.00	0.77	0.00	5020.00	0.00	294.25	294.25	5340.83	0.00	4988.50	0.00	421.00	421.00	8046.45	45824.75	5043.75	1193.00
1.0	0.4	0.05	0	4407730.25	0.48	1544.75	1010.75	467.25	1010.75	543.50	6581.32	2241.25	995.25	259.00	995.25	736.25	12063.07	46777.75	980.75	980.75
1.0	0.4	0.05	1	3675286.00	0.86	0.00	1010.75	0.00	365.50	365.50	7062.81	0.00	995.25	0.00	459.75	459.75	8720.21	279.00	980.75	540.25
1.0	0.4	0.05	2	4455632.75	0.71	83.00	1010.75	6.50	464.25	457.75	8613.70	15.00	995.25	0.00	523.75	523.75	10162.38	15408.50	980.75	783.00
1.0	0.4	0.1	0	3345096.25	0.35	268.50	486.25	65.50	486.25	420.75	7048.45	260.75	511.00	25.25	511.00	485.75	8911.94	7683.50	489.75	489.75
1.0	0.4	0.1	1	2937676.00	0.87	0.00	486.25	0.00	334.75	334.75	6134.24	0.00	511.00	0.00	383.25	383.25	7462.44	56.75	489.75	396.25
1.0	0.4	0.1	2	3803831.50	0.48	28.25	486.25	0.00	483.25	483.25	9015.95	76.00	511.00	3.75	506.50	502.75	9422.32	392.00	489.75	489.50
1.0	0.5	0.005	0	4505693.25	0.49	24749.50	9987.50	9631.25	9987.50	356.25	638.77	56147.25	9952.75	8627.00	9952.75	1325.75	8137.05	177938.00	9979.50	9979.50
1.0	0.5	0.005	1	2906190.75	0.78	0.00	9987.50	0.00	169.00	169.00	3000.68	0.00	9952.75	0.00	438.75	438.75	8054.40	407.75	9979.50	722.75
1.0	0.5	0.005	2	4066388.25	0.77	0.00	9987.50	0.00	312.00	312.00	5794.58	0.00	9952.75	0.00	419.75	419.75	7901.44	41664.00	9979.50	1126.25
1.0	0.5	0.01	0	4454983.00	0.49	11876.50	4979.25	4495.75	4979.25	483.50	1665.26	26127.00	4987.50	3912.00	4987.50	1075.50	7296.95	145106.75	5002.50	5002.50
1.0	0.5	0.01	1	2954861.00	0.78	0.00	4979.25	0.00	189.25	189.25	3424.79	0.00	4987.50	0.00	421.75	421.75	7917.52	238.50	5002.50	690.50
1.0	0.5	0.01	2	4131111.75	0.77	0.00	4979.25	0.00	313.50	313.50	5806.19	0.00	4987.50	0.00	410.75	410.75	7648.82	45058.00	5002.50	1182.50
1.0	0.5	0.05	0	4283770.75	0.45	1445.00	1003.25	476.00	1003.25	527.25	6795.25	2415.50	1005.75	299.75	1005.75	706.00	11076.54	34775.50	990.50	990.50
1.0	0.5	0.05	1	3503492.25	0.85	0.00	1003.25	0.00	368.50	368.50	7412.45	0.00	1005.75	0.00	449.50	449.50	8538.53	138.75	990.50	502.75
1.0	0.5	0.05	2	4465906.00	0.72	152.25	1003.25	7.00	448.75	441.75	8268.09	22.50	1005.75	0.00	527.50	527.50	10514.41	14968.25	990.50	789.00
1.0	0.5	0.1	0	3001774.25	0.31	377.75	496.00	118.00	496.00	378.00	6560.03	717.25	500.75	73.50	500.75	427.25	6854.09	15909.50	508.25	508.25
1.0	0.5	0.1	1	2639007.50	0.85	0.00	496.00	0.00	303.25	303.25	5940.07	0.00	500.75	0.00	336.75	336.75	5940.31	29.50	508.25	381.25
1.0	0.5	0.1	2	3683538.75	0.50	68.50	496.00	23.25	493.00	469.75	8777.07	234.00	500.75	12.50	494.75	482.25	8343.15	271.50	508.25	507.75
1.0	0.6	0.005	0	4520654.25	0.49	25026.75	9970.00	9608.00	9970.00	362.00	900.99	56336.00	9970.00	8565.50	9970.00	1404.50	9058.24	170868.00	10025.75	10025.75
1.0	0.6	0.005	1	3078064.00	0.79	0.00	9970.00	0.00	162.00	162.00	3093.50	0.00	9970.00	0.00	428.25	428.25	8328.41	349.75	10025.75	719.50
1.0	0.6	0.005	2	4136419.25	0.77	0.00	9970.00	0.00	312.50	312.50	5996.73	0.00	9970.00	0.00	429.75	429.75	8011.87	42026.50	10025.75	1145.50
1.0	0.6	0.01	0	4491490.00	0.49	11794.25	4999.00	4542.50	4999.00	456.50	1969.07	26652.00	5034.75	3992.50	5034.75	1042.25	7774.85	137311.75	5035.50	5035.50
1.0	0.6	0.01	1	3178880.00	0.79	0.00	4999.00	0.00	216.00	216.00	3926.12	0.00	5034.75	0.00	430.00	430.00	8216.84	336.50	5035.50	672.75
1.0	0.6	0.01	2	4162715.00	0.78	0.00	4999.00	0.00	300.25	300.25	5591.38	0.00	5034.75	0.00	441.50	441.50	8402.06	43619.00	5035.50	1139.50
1.0	0.6	0.05	0	3823875.00	0.41	1460.00	985.50	531.75	985.50	453.75	5991.10	2567.25	1004.00	353.25	1004.00	650.75	9480.66	29953.25	977.50	977.50
1.0	0.6	0.05	1	3017403.75	0.84	0.00	985.50	0.00	335.75	335.75	5954.87	0.00	1004.00	0.00	412.50	412.50	7466.52	178.50	977.50	467.25
1.0	0.6	0.05	2	4412523.75	0.74	88.75	985.50	12.75	459.25	446.50	8079.05	8.75	1004.00	0.00	524.25	524.25	9921.34	16214.75	977.50	791.25
1.0	0.6	0.1	0	2657702.50	0.28	486.75	515.25	144.25	515.25	371.00	5494.45	834.50	498.25	97.25	498.25	401.00	6654.12	18666.75	497.75	497.75
1.0	0.6	0.1	1	2308909.50	0.82	0.00	515.25	0.00	277.25	277.25	4875.34	0.00	498.25	0.00	300.25	300.25	5833.83	8.50	497.75	338.75
1.0	0.6	0.1	2	3666307.50	0.52	88.00	515.25	21.50	510.00	488.50	8506.90	226.75	498.25	9.50	489.25	479.75	9291.28	290.75	497.75	497.50

p_{EGW}	p_{ER0}	λ^{-1}	TE	packets	lu	EF						AF						BE		
						drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cfail	cacc	csuc	ssuc	drops	ctotal	cacc
1.0	0.7	0.005	0	4507250.75	0.49	24751.75	9983.25	9560.25	9983.25	423.00	1269.80	56165.00	10075.50	8540.00	10075.50	1535.50	11371.10	162044.50	10057.75	10057.75
1.0	0.7	0.005	1	2739134.75	0.77	0.00	9983.25	0.00	141.25	141.25	2458.20	0.00	10075.50	0.00	393.50	393.50	7952.06	410.00	10057.75	649.25
1.0	0.7	0.005	2	4085256.25	0.78	0.00	9983.25	0.00	308.25	308.25	5547.84	0.00	10075.50	0.00	443.00	443.00	8538.39	41536.75	10057.75	1111.00
1.0	0.7	0.01	0	4482986.25	0.49	11817.00	4992.50	4498.00	4992.50	494.50	2833.26	26107.25	4951.75	3889.50	4951.75	1062.25	9116.36	126651.75	4998.75	4998.75
1.0	0.7	0.01	1	3309577.00	0.79	0.00	4992.50	0.00	245.75	245.75	4800.07	0.00	4951.75	0.00	431.00	431.00	7822.72	262.25	4998.75	651.50
1.0	0.7	0.01	2	4173124.50	0.78	0.00	4992.50	0.00	295.25	295.25	5561.47	0.00	4951.75	0.00	395.75	395.75	7544.06	44400.75	4998.75	1125.50
1.0	0.7	0.05	0	3412966.75	0.35	1556.00	1027.25	590.75	1027.25	436.50	6509.38	3223.25	1019.25	471.00	1019.25	548.25	7877.16	30830.00	983.50	983.50
1.0	0.7	0.05	1	2650580.25	0.83	0.00	1027.25	0.00	306.50	306.50	5613.72	0.00	1019.25	0.00	343.50	343.50	6685.07	115.75	983.50	393.75
1.0	0.7	0.05	2	4474066.00	0.74	21.00	1027.25	0.00	456.75	456.75	9018.11	12.25	1019.25	0.00	503.75	503.75	9242.99	15640.25	983.50	750.75
1.0	0.7	0.1	0	2196978.75	0.23	635.75	489.25	194.50	489.25	294.75	3857.89	1143.00	504.75	134.75	504.75	370.00	5666.63	21588.75	507.00	507.00
1.0	0.7	0.1	1	1885704.50	0.77	0.00	489.25	0.00	210.75	210.75	3759.33	0.00	504.75	0.00	238.50	238.50	4342.07	33.00	507.00	282.00
1.0	0.7	0.1	2	3609322.75	0.55	100.50	489.25	12.75	478.25	465.50	8286.21	269.50	504.75	9.25	489.50	480.25	9046.85	511.25	507.00	505.75
1.0	0.8	0.005	0	4469665.00	0.49	25612.75	10005.00	9570.75	10005.00	434.25	1890.95	55010.00	10093.00	8425.25	10093.00	1667.75	13797.63	149673.25	9997.75	9997.75
1.0	0.8	0.005	1	3143486.75	0.79	0.00	10005.00	0.00	196.50	196.50	3813.52	0.00	10093.00	0.00	458.75	458.75	8832.26	431.75	9997.75	685.00
1.0	0.8	0.005	2	4066533.25	0.79	0.00	10005.00	0.00	306.75	306.75	5647.79	0.00	10093.00	0.00	447.50	447.50	8247.14	41027.00	9997.75	1137.00
1.0	0.8	0.01	0	4472718.50	0.49	11661.00	4997.00	4503.25	4997.00	493.75	3772.60	26781.50	4967.50	3937.50	4967.50	1030.00	10581.78	112658.75	5032.75	5032.75
1.0	0.8	0.01	1	3382857.50	0.82	0.00	4997.00	0.00	276.50	276.50	5476.49	0.00	4967.50	0.00	431.50	431.50	7819.63	374.75	5032.75	615.00
1.0	0.8	0.01	2	4133060.50	0.79	0.00	4997.00	0.00	298.00	298.00	5432.56	3.00	4967.50	0.50	411.25	410.75	7858.06	43282.00	5032.75	1115.50
1.0	0.8	0.05	0	2696607.00	0.28	1763.25	1001.50	669.25	1001.50	332.25	4335.37	4052.00	1042.75	592.50	1042.75	450.25	5506.14	32404.25	996.75	996.75
1.0	0.8	0.05	1	2151347.50	0.80	0.00	1001.50	0.00	233.25	233.25	4413.79	0.00	1042.75	0.00	272.25	272.25	5106.00	43.50	996.75	309.00
1.0	0.8	0.05	2	4339037.00	0.74	54.25	1001.50	12.00	455.50	443.50	8448.19	49.50	1042.75	0.75	512.25	511.50	9631.52	14941.00	996.75	757.50
1.0	0.8	0.1	0	1840468.25	0.20	697.75	492.75	262.25	492.75	230.50	2784.81	1558.50	512.50	192.00	512.50	320.50	4334.21	22395.00	483.75	483.75
1.0	0.8	0.1	1	1637544.50	0.74	0.00	492.75	0.00	169.25	169.25	3108.68	0.00	512.50	0.00	222.25	222.25	3901.41	19.25	483.75	251.75
1.0	0.8	0.1	2	3411229.00	0.52	202.50	492.75	55.25	483.75	428.50	7509.02	388.50	512.50	19.25	497.75	478.50	8552.24	264.25	483.75	482.50
1.0	0.9	0.005	0	4484282.00	0.49	25762.25	9975.25	9495.50	9975.25	479.75	3961.64	54143.50	9967.50	8250.00	9967.50	1717.50	18984.51	120824.75	9924.25	9924.25
1.0	0.9	0.005	1	3286295.75	0.82	0.00	9975.25	0.00	255.00	255.00	4722.73	0.00	9967.50	0.00	443.00	443.00	8397.23	551.75	9924.25	591.00
1.0	0.9	0.005	2	4121899.50	0.79	0.00	9975.25	0.00	294.25	294.25	5374.98	0.00	9967.50	0.00	431.25	431.25	8154.82	39773.00	9924.25	1065.75
1.0	0.9	0.01	0	4292663.50	0.46	11613.25	4970.00	4509.75	4970.00	460.25	6104.07	26113.50	4923.25	4007.25	4923.25	916.00	10957.63	63322.00	5037.50	5037.50
1.0	0.9	0.01	1	3310164.50	0.84	0.00	4970.00	0.00	357.25	357.25	7021.44	0.00	4923.25	0.00	430.75	430.75	7981.70	354.00	5037.50	586.50
1.0	0.9	0.01	2	4144952.25	0.78	34.25	4970.00	4.25	323.50	319.25	5970.34	0.00	4923.25	0.00	437.50	437.50	8239.47	39434.25	5037.50	1095.75
1.0	0.9	0.05	0	1866398.75	0.20	2049.50	987.00	783.25	987.00	203.75	2276.42	4538.50	1019.50	670.00	1019.50	349.50	3444.02	33912.75	1006.25	1006.25
1.0	0.9	0.05	1	1537087.50	0.73	0.00	987.00	0.00	158.00	158.00	3021.11	0.00	1019.50	0.00	206.75	206.75	3757.82	63.00	1006.25	250.75
1.0	0.9	0.05	2	3961134.50	0.69	44.50	987.00	1.50	395.00	393.50	7695.43	37.50	1019.50	0.25	452.25	452.00	8470.06	16729.75	1006.25	729.00
1.0	0.9	0.1	0	1505740.25	0.16	865.50	494.25	297.75	494.25	196.50	1927.56	1664.00	489.50	205.00	489.50	284.50	3519.57	23468.00	465.75	465.75
1.0	0.9	0.1	1	1323801.25	0.69	0.00	494.25	0.00	143.50	143.50	2649.13	0.00	489.50	0.00	165.50	165.50	3260.60	16.00	465.75	187.50
1.0	0.9	0.1	2	3332542.25	0.54	209.25	494.25	45.00	470.50	425.50	7821.48	252.25	489.50	8.50	455.00	446.50	8310.81	661.25	465.75	463.00
1.0	1.0	0.005	0	1144012.75	0.12	27080.25	10024.50	9959.50	10024.50	65.00	9.26	55714.75	9934.25	8681.75	9934.25	1252.50	11437.81	61726.25	9981.25	9981.25
1.0	1.0	0.005	1	495582.00	0.63	0.00	10024.50	0.00	12.75	12.75	258.86	0.00	9934.25	0.00	68.25	68.25	1421.47	114.75	9981.25	124.25
1.0	1.0	0.005	2	2972027.50	0.60	0.00	10024.50	0.00	187.25	187.25	3828.56	0.50	9934.25	0.00	336.25	336.25	6192.28	31819.25	9981.25	838.75
1.0	1.0	0.01	0	1147258.00	0.12	12611.50	4935.50	4867.00	4935.50	68.50	34.84	29212.50	4968.50	4492.00	4968.50	476.50	3010.15	53573.75	5039.75	5039.75
1.0	1.0	0.01	1	620381.75	0.63	0.00	4935.50	0.00	34.00	34.00	604.46	0.00	4968.50	0.00	89.50	89.50	1666.97	124.25	5039.75	126.25
1.0	1.0	0.01	2	2995535.00	0.60	0.00	4935.50	0.00	206.75	206.75	4040.97	0.00	4968.50	0.00	313.75	313.75	6019.06	37349.00	5039.75	887.25
1.0	1.0	0.05	0	1116331.50	0.12	2328.75	1008.00	888.25	1008.00	119.75	386.05	5079.25	1004.75	748.50	1004.75	256.25	1748.47	34695.50	991.25	991.25
1.0	1.0	0.05	1	723073.50	0.64	0.00	1008.00	0.00	51.00	51.00	984.85	0.00	1004.75	0.00	91.50	91.50	1858.89	42.75	991.25	142.25
1.0	1.0	0.05	2	3314071.00	0.60	16.25	1008.00	2.75	308.75	306.00	5740.16	2.75	1004.75	0.00	376.25	376.25	7172.13	21530.75	991.25	673.50
1.0	1.0	0.1	0	1112306.50	0.12	1040.00	507.25	364.75	507.25	142.50	852.99	2123.50	510.50	286.00	510.50	224.50	2311.67	26483.50	484.25	484.25
1.0	1.0	0.1	1	814276.75	0.64	0.00	507.25	0.00	60.00	60.00	1141.43	0.00	510.50	0.00	100.00	100.00	2257.26	45.50	484.25	128.00
1.0	1.0	0.1	2	3138710.00	0.54	136.25	507.25	34.25	424.75	390.50	7119.24	267.25	510.50	6.00	424.00	418.00	8491.00	2412.50	484.25	470.00

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